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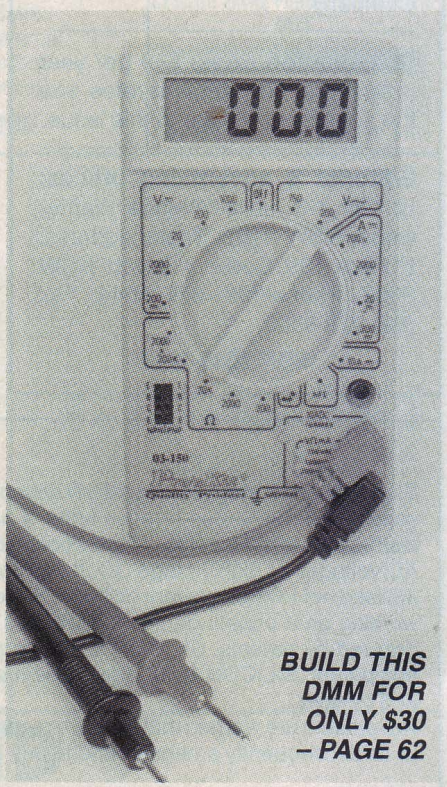

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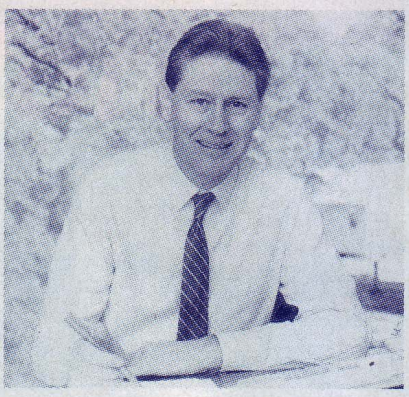
PUBLISHER'S LETTER

Computers can be a fire hazard



Yes, computers can be a fire hazard. There have been a number of serious domestic fires reported in the media recently and these have pointed up the risk of leaving computers on and unattended for long periods. My advice to anyone with a computer is don't leave it on any longer than necessary. This applies equally to computers used at home and in industry.

I am amazed at the number of companies who leave their computers running all the time, whether anyone is on the premises or not. Maybe they do this because of a belief that computers are more reliable if left running continuously but they are mistaken. It is bad practice, from a number of points of view. First, there is the considerable cost of running these machines all day, every day. Even if there was an improvement in reliability, the cost of the energy to run each computer continuously would easily outweigh the cost of a breakdown.

Second, the longer computers are left running, the sooner they will fail and this applies particularly to the monitor and to hard disc drives which run all the time, whether there is hard disc activity or not. Third, the longer a computer is left running, the more likely it is to experience a power interruption or worse, a voltage surge. Such events can easily cause damage.

Think about the occurrence of thunderstorms. They usually occur in the late afternoon or evening and they often cause blackouts or power surges. The risk is greatly increased if the machine is connected to a telephone line via a modem. Many fax machines and modems are damaged during thunderstorms, and so are computers.

If it is good practice to disconnect your computer during a thunderstorm, particularly if it has a modem connected, then it is also good practice to have computers turned off and disconnected, while no-one is on the premises. If the computer is disconnected, it can't be damaged by power surges and it certainly can't catch fire and cause the premises to be burnt down. If a computer must be left running all the time, then the monitor should be turned off when not needed.

Colour TVs are a known fire risk in homes and should not be left running unattended for long periods. They should not even be left on standby for long periods, because of this risk. And nor should computers. As with colour TVs, they employ switchmode power supplies which are directly connected to the 240VAC AC mains, and their monitors employ high voltage (EHT) supplies which can arc over and start a fire.

By all means, leave your computer on during the day, even if you are using it only intermittently. But don't trust it when you are not there. Turn it off.

Leo Simpson

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SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely. Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine. Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

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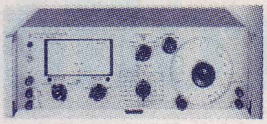

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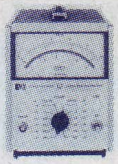

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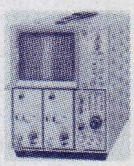

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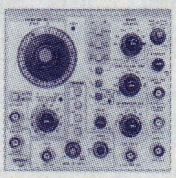

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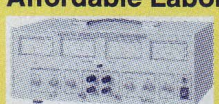

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Electronically-controlled system for EFI engines

Traditional LPG conversions of EFI engines involve fitting a simple carburettor to the air intake system & bypassing the fuel injectors during LPG running. This new system feeds the LPG to the fuel injectors & features an advanced electronic control unit.

By JULIAN EDGAR

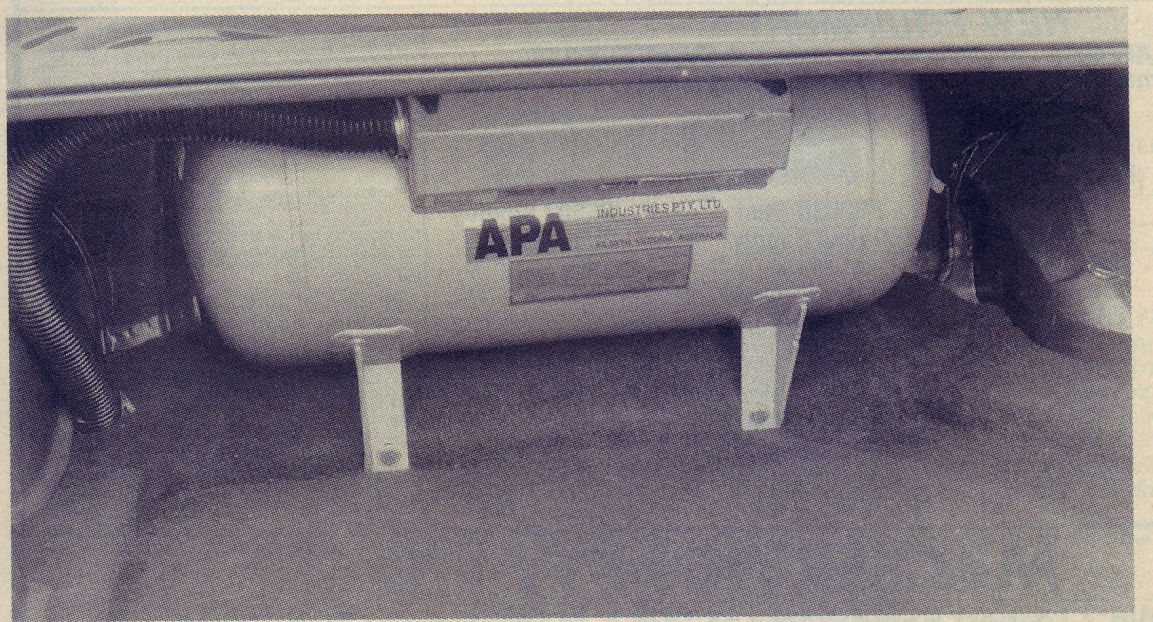
Aftermarket LPG (liquid petroleum gas) systems for cars have been available for many years, with both Ford and Holden now also offering factory-fitted systems. However, the technology used in converting a petrol engine to run on LPG has been fairly basic.

Until recently, there has been no use of mixture-monitoring feedback loops, although the design rules now state that the emissions level from a petrol engine must not be degraded by the conversion to gas. As a result, the oxygen sensor is used on current systems as a control input.

Even systems that are factory-fitted to EFI vehicles use a traditional converter (which changes the LPG from a liquid to a gas) and a mixer (essentially a simple carburettor) which adds the gas to the intake airstream ahead of the throttle butterfly. In other words, no use is made of the fuel injectors or other mechanical elements built into the EFI engines used in these vehicles. In addition, the electronic control methods used for LPG fuel metering tend to be far simpler than those employed for petrol injection systems.

Now, however, a South Australian company has introduced new technology which is said to overcome many of these deficiencies. The company, Liquiphase Management Pty Ltd, has developed a new system which uses full electronic control to inject LPG in liquid form through the factory-fitted petrol injectors. Their system is currently only available for Falcons but development of a Holden V6 system is also under way, with others likely to follow.

Improvements over traditional LPG systems are claimed in the areas of power, economy and starting. In fact, Liquiphase has chassis dynamometer sheets which show an improvement in power over the same engine run-



The LPG tank mounts in the conventional boot location & differs only slightly from any other automotive LPG tank.

LPG

ning on petrol! Given that there is almost universally a power decrease when running on LPG as compared to petrol, the latter point is quite intriguing.

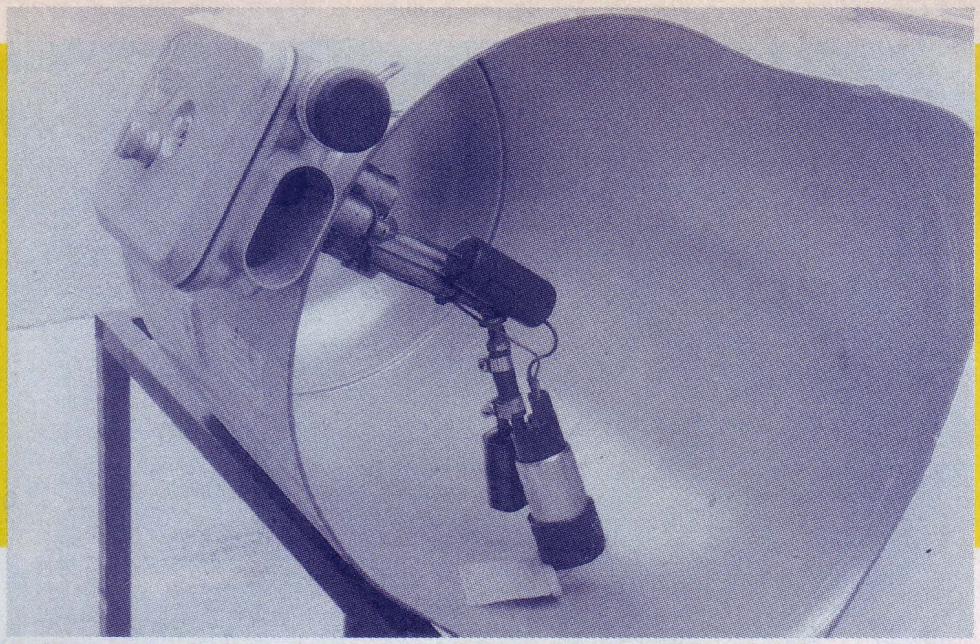
Mechanical layout

Starting at the rear of the car, the Liquiphase system differs from a traditional LPG system by using a pump within the boot-mounted LPG cylinder. Normally fitted to the electronic fuel injection system used in Magnas, the roller-cell pump is submerged within the liquid and increases the fuel pressure to 250kPa above the tank pressure (which varies depending upon temperature). The other major difference in the tank is the provision for a return line, as found in EFI petrol systems.

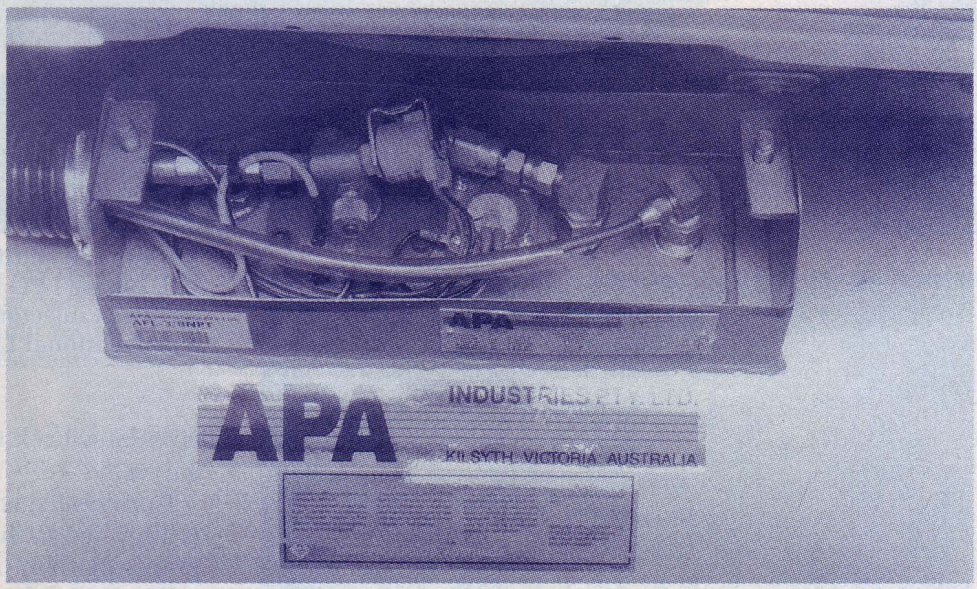
Under the bonnet, the system looks quite unlike a conventional LPG system. Two new fuel rails are used, the top fuel rail supplying the injectors in the conventional manner but having more plumbing connections. The bottom fuel rail uses collars which fit around the base of the Ford injectors, with the fuel flowing through a slot which is cut into the bottom section of the injector for this purpose. The LPG (in liquid form) is then sprayed through the injector's nozzle each time it opens.

This method of "bottom feeding" the fuel injectors is necessary to prevent fuel vaporisation. If top-fed to the injectors in the conventional manner, the LPG can vaporise as it passes around the relatively warm solenoids.

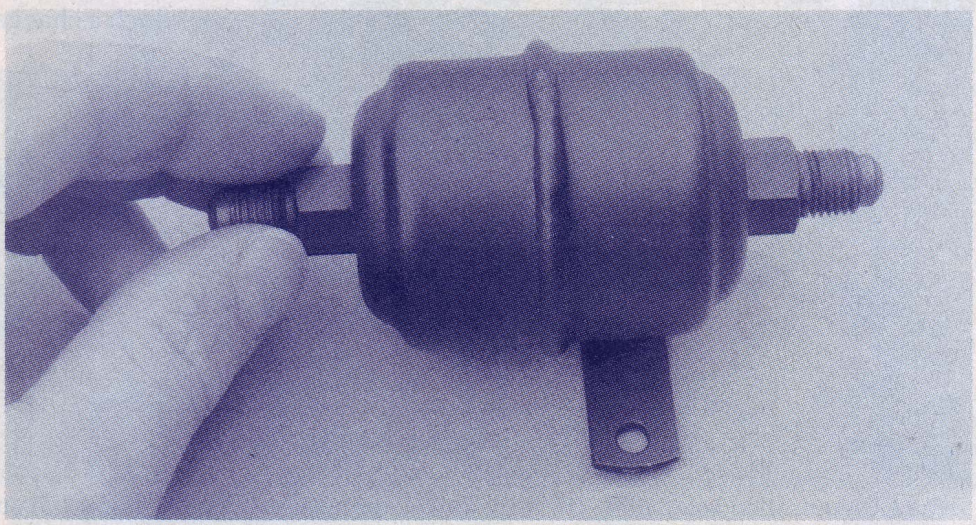
Any LPG which is surplus to the engine's requirements flows out through the top of the injectors and into the upper fuel rail. This fuel then



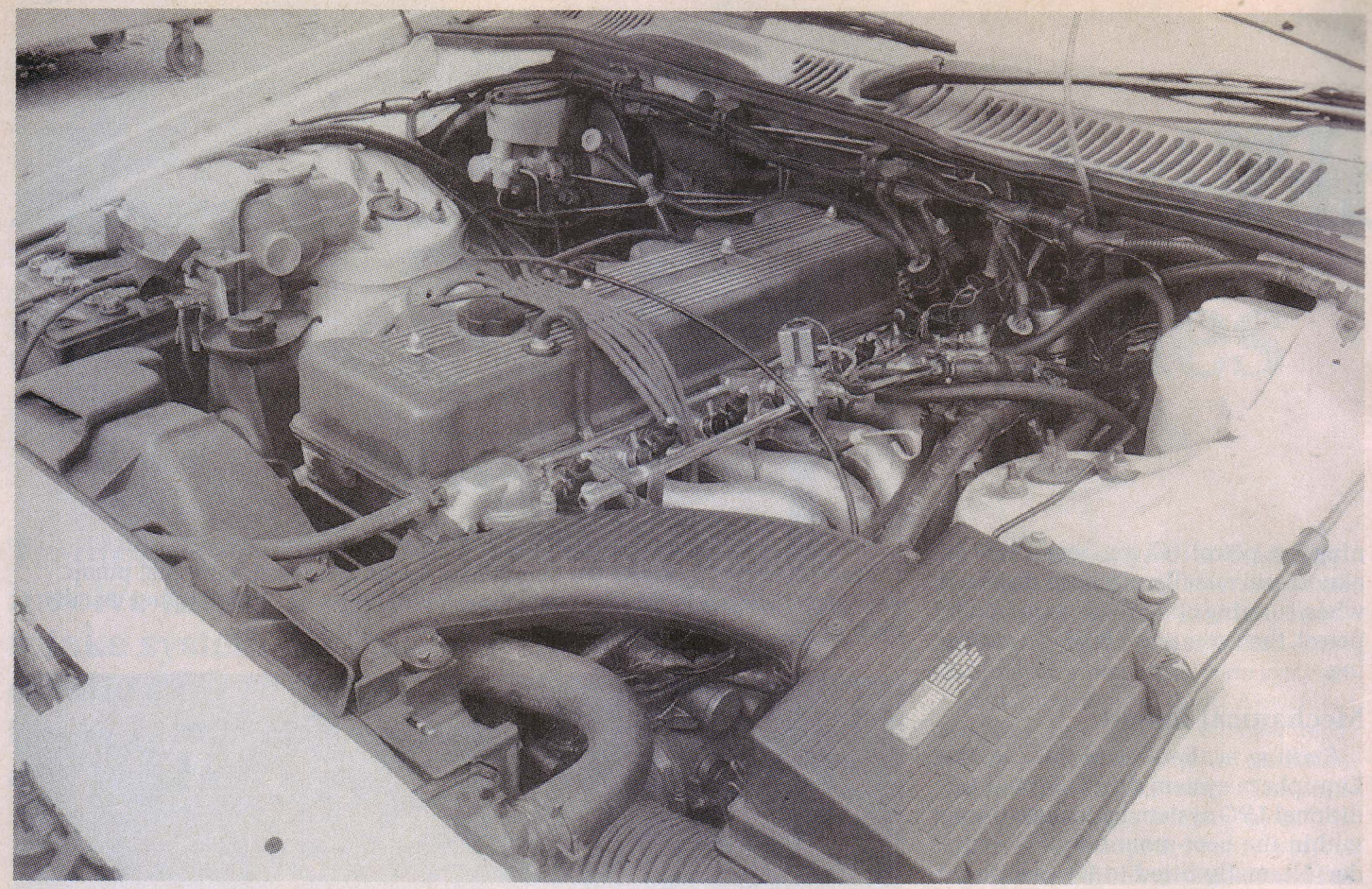
Unlike other LPG systems, the Liquiphase design uses an in-tank fuel pump, which can be seen in this cutaway view. Based on an EFI petrol pump usually used in Magnas, this operates at 250kPa above tank pressure.



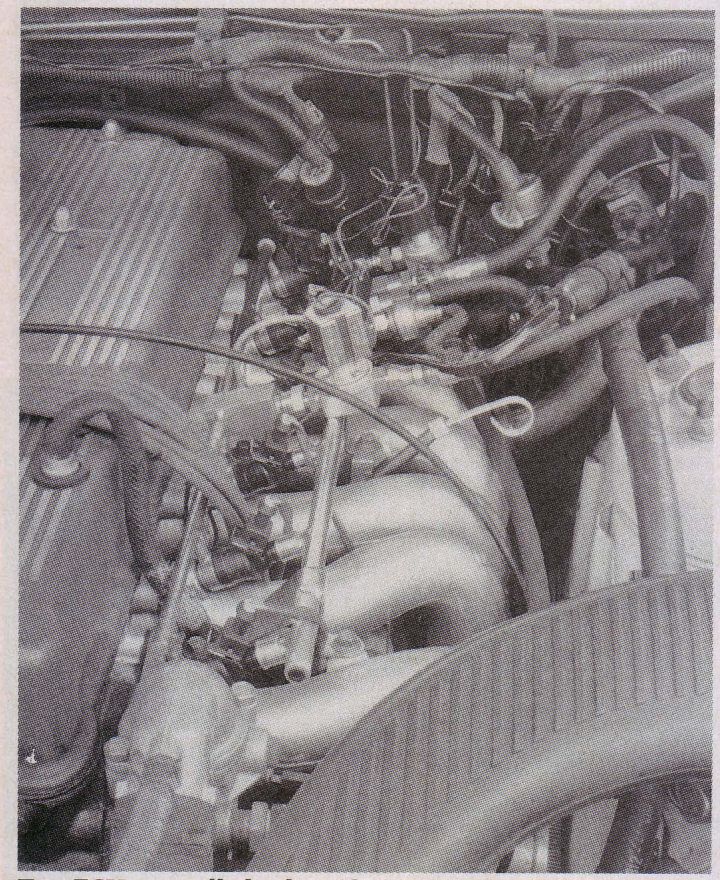
Differences from other LPG tanks include the provision of a return fuel line & the use of a flanged fitting to allow the insertion & removal of the fuel pump.



An in-line filter is used to prevent small particles blocking the injectors. Unlike a conventional EFI filter, this must operate at the very high pressures associated with a gas system.



Above: The additional equipment required by the Liquiphase LPG injection system is positioned near to the stock injector location. The gas converter & mixer of a conventional LPG system are absent.

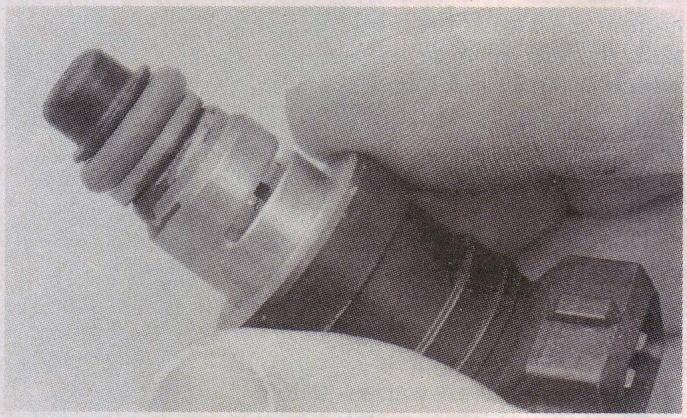


Two ECU-controlled solenoids, two mechanical one-way valves & two fuel rails are used in the Liquiphase LPG system. Fuel rail pressure & temperature sensors are also fitted to provide inputs to the new ECU.

circulates back to the LPG tank via two one-way check valves.

Conversely, when the car is running on petrol, the fuel is supplied to the injectors via the conventional top feed points by the upper fuel rail. As a result, the upper fuel rail is not solely a "petrol rail" and, in fact, there are times when the flows of fuel actually mix. This occurs during the change-over from LPG to petrol, for example.

Such a change-over needs to be provided if the system



The stock Falcon injectors are modified by having a slot cut into one side. This provides the LPG supply point for the injectors & prevents the fuel vaporisation that would otherwise occur if the injectors were "top-fed".

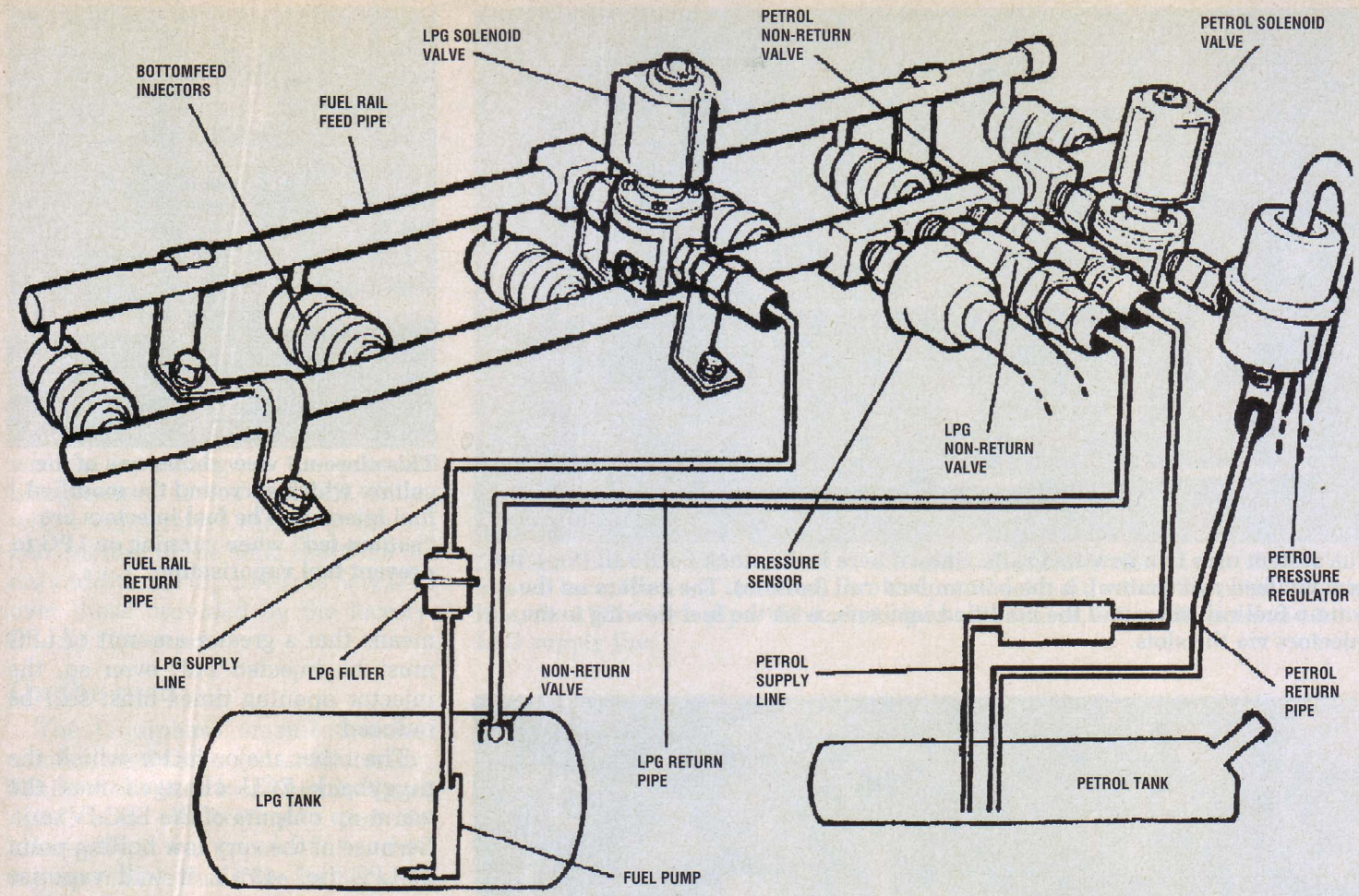


Fig.1: basic layout of the Liquiphase LPG injection system. Unlike other LPG conversion systems, it feeds the LPG to the car's existing fuel injectors & features an advanced electronic control unit (ECU) which mates with the existing ECU. This ensures optimum performance when running on LPG.

is to be acceptable in the marketplace. In addition, the system must be engineered so that the car is easy to start and yet comply with the design rules. These rules state that LPG cannot be allowed to circulate unless the engine is being started or is running.

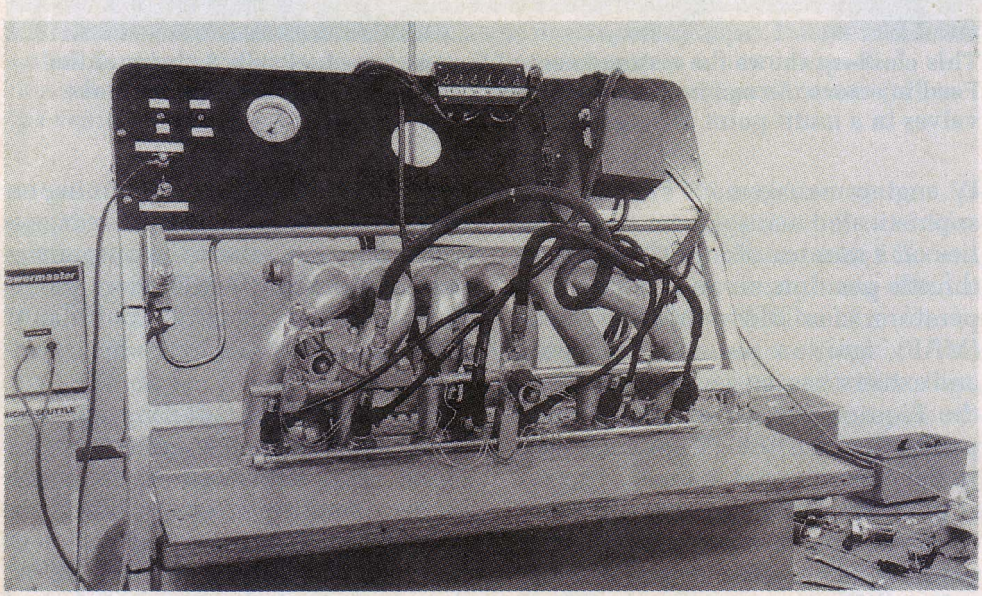
This precludes the use of an automatic circulation system when the engine is stopped. As a result, the LPG can vaporise in the fuel rail because of underbonnet heat-soak. In a worst-case scenario, it can take up to 60 seconds for the vaporised LPG to be displaced by liquid LPG and this would obviously lead to poor starting performance.

To overcome this problem, the Liquiphase-injected engine is run on petrol provided by a "third party" seventh injector during a fuel changeover or when the car is being hot-started. This seventh injector is positioned prior to the inlet plenum chamber and supplies enough fuel for the engine to be driven at up to about 75% throttle opening.

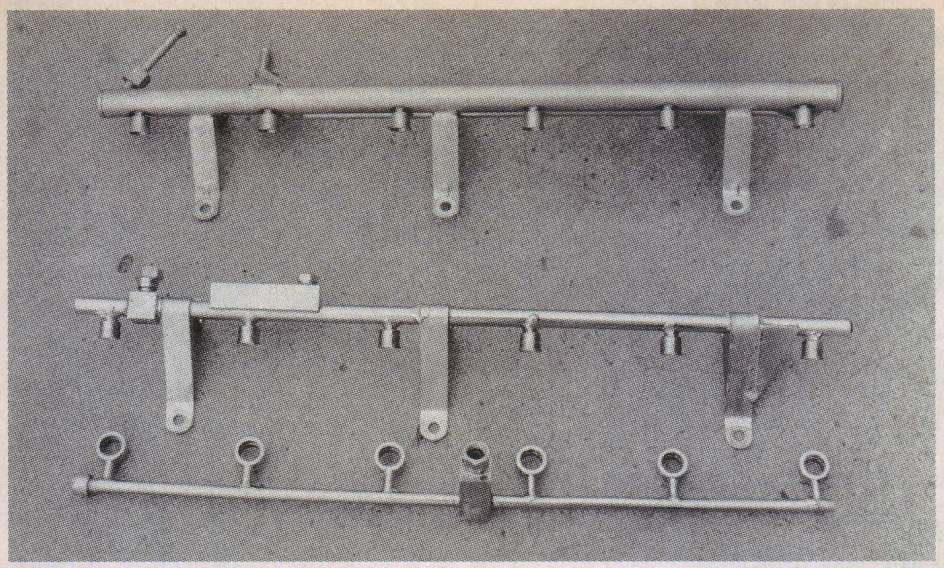
During a change from gas to petrol, for example, the conventional six injectors are initially shut off and the engine is run on petrol from the seventh. The pressure is then reduced in the fuel rails until it drops below 250kPa, whereupon petrol flows into the top rail through a one-way valve, flushing out any remaining gas vapour in the process. When this process is complete, the multi-point injection system takes over and the extra injector is switched off.

Electronic control

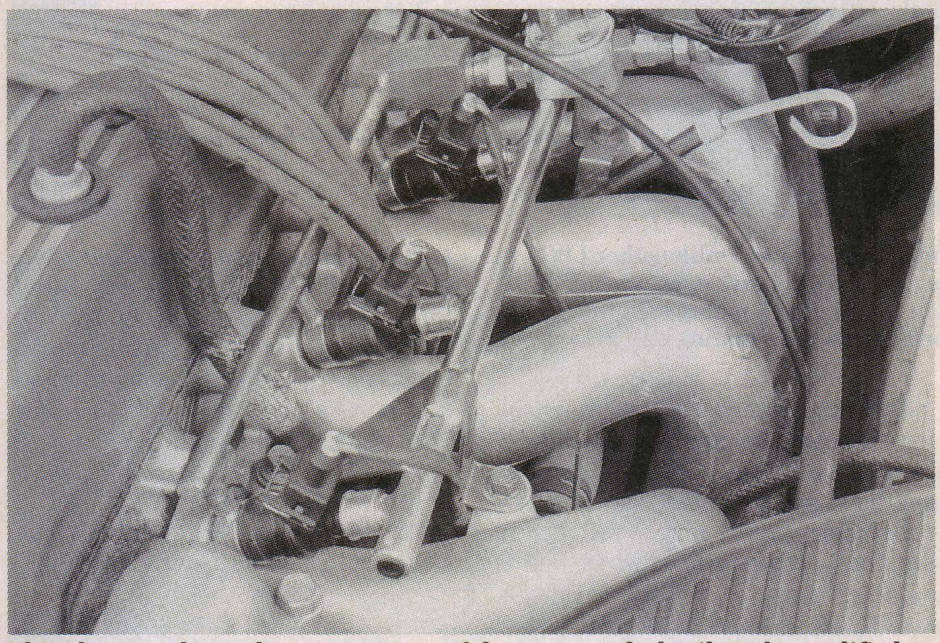
Cars to which the system is currently being fitted use the Ford EEC-



After the slot has been cut into its side, the injector is flushed & tested on this rig to ensure that no particles of metal remain.



The system uses two new fuel rails. Shown here is the stock Ford rail (top), the new top feed rail (centre), & the bottom feed rail (bottom). The collars on the bottom fuel rail surround the modified injectors, with the fuel flowing to the injectors via the slots.



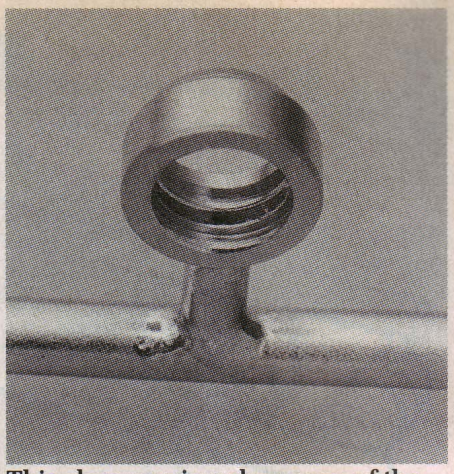
This close-up shows the arrangement of the two new fuel rails & the modified Ford injectors. As can be seen, both fuels are injected just behind the intake valves in a multi-point arrangement.

IV engine management system. This sophisticated management system relies on a number of inputs, including throttle position, air and coolant temperature, manifold absolute pressure (MAP), ignition pulses, road speed and exhaust gas oxygen content. When the Liquiphase cars are running on petrol, the Ford EEC-IV system is used in the conventional manner.

In other words, the cars run in exactly the same manner as unmodified vehicles when petrol is used.

Two different approaches have been used to control the fuel injectors and the ignition timing when running on LPG. The first system used a piggyback approach, where the output signals of the EEC-IV ECU were modified by another electronic control unit before being applied to the fuel injectors.

In general, the injector opening times for LPG are shorter than for petrol. This is because of the much higher operating pressures of the gas system, which ensures that sufficient fuel flow occurs in a shorter time. At the same time, the energy value of LPG is lower than that of petrol. This



This close-up view shows one of the collars which surround the modified fuel injectors. The fuel injectors are "bottom-fed" when running on LPG to prevent fuel vaporisation.

means that a greater amount of LPG must be injected but, even so, the injector opening times must still be reduced.

The other major factor which the piggyback ECU changed was the warm-up outputs of the EEC-IV unit. Because of the very low boiling point of LPG (ie, -43°C), it will vaporise even at very low temperatures. As a result, the normal cold-start injector pulse width extension required for petrol operation was found to be unnecessary for LPG and so this function was eliminated.

However, the piggyback system did have some problems, due mainly to the fact that the ignition timing remained the same for both petrol and LPG. In practice, this gave some problems with driveability. LPG has different burning characteristics to petrol and therefore needs different ignition timing to give the best performance.

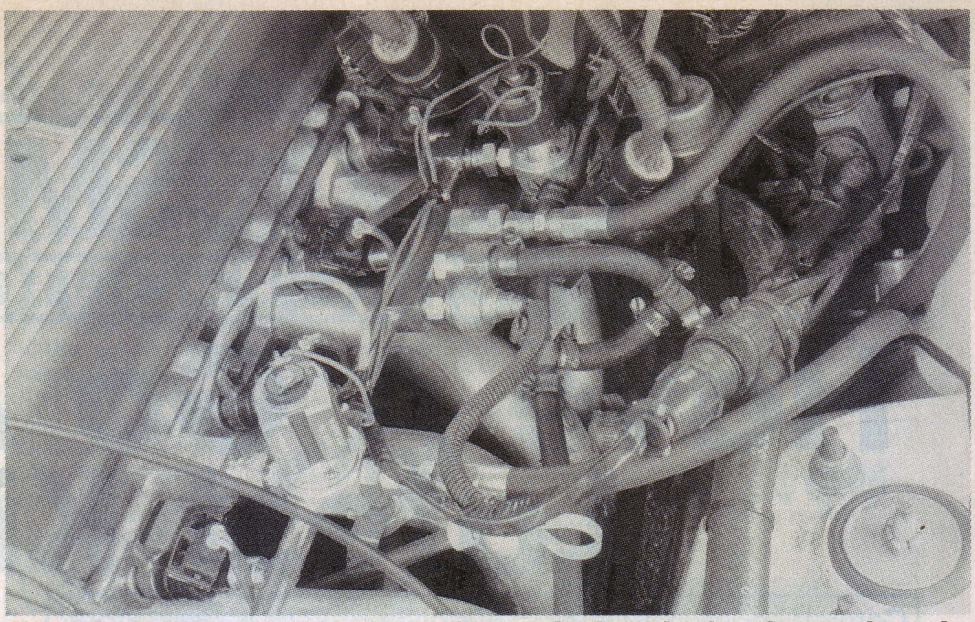
Programmable ECU

As a result, Liquiphase decided to use a fully-programmable aftermarket ECU to drive the LPG system and Injec were commissioned to do the development work. This new ECU uses all of the inputs fed to the original unit, picking these up via an interconnecting panel which fits between the car's standard wiring harness and the EEC-IV ECU (which is retained).

Both the ignition timing and the fuel injector pulse widths are calculated on the basis of look-up maps, which use a light and full load axis every 500rpm of engine speed. This

system is said to be able to interpolate accurately within this framework, giving a "very large" number of different outputs. In addition, the new ECU produces 48V injector "pull-on" pulses so that the injectors open in the same time as for operation with petrol, this despite the fact that the LPG pressure can be up to 10 times higher. Following this initial 48V pulse, the injectors are held on using just 12V.

Because the pressure of the gas system varies with temperature, the system changes the fuel injector pulse widths depending on the pressure being sensed in the fuel rail. Along with a temperature sensor in the rail and another in the tank, these are the only additional inputs to the new ECU over those provided by the factory-fitted EFI sensors.



Shown here, from top to bottom, are the petrol solenoid valve, the petrol supply line, the LPG return pipe, the fuel rail pressure sensor, & the LPG solenoid & LPG supply line.

On the road

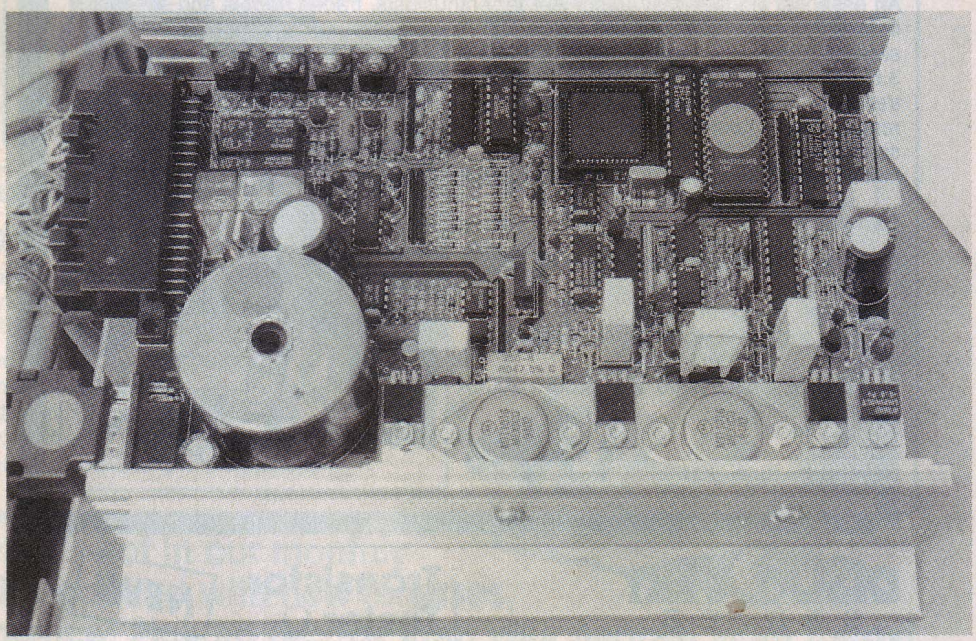
The Liquiphase organisation had available a Falcon sedan for testing. While the system looks highly-developed, both electronically and mechanically, it was apparent after driving the vehicle that some further work still needs to be carried out.

When running on LPG, the car drove well, with normal responsiveness and other behaviour. The same goes for petrol operation. On the debit side, the fuel changeover was clumsy, with the change from gas to petrol being somewhat protracted. While undergoing this change, Liquiphase recommends that the car not be driven but instead be fast-idled by the side of the road while the seventh injector supplies the fuel.

However, on the advice of a technical officer who was present, we drove the car gently during the changeover period. It took several minutes for the car to switch to petrol and more than very gentle throttle action resulted in engine misfires. In one case, the engine had successfully changed from gas to petrol only to then go back to seventh-injector (low power) running. Software glitches were blamed for this behaviour.

The performance testing was also interesting. The denser charge caused by the heat lost through the latent heat of evaporation of the fuel resulted in improved power torque while running on LPG. This was shown in the supplied dynamometer charts.

Hand-timed 0-100km/h runs in the automatic Falcon indicated an average time of 10.0 seconds on petrol, while on gas the time was reduced to 9.7 seconds. However, on rolling 60-90km/h splits, the car was slower on LPG with a time of 3.6 seconds versus 3.5 seconds for petrol. From this, it would appear that further fine tuning of the ignition and fuel maps is required to maximise the performance on LPG.



The LPG electronic control unit (ECU) was developed by Injec. It uses the sensor inputs of the existing engine management system & has unique fuel injector pulse width & ignition timing maps to give optimal performance when the vehicle is running on LPG.

Conclusion

By adopting a sophisticated electronic and mechanical approach, the Liquiphase LPG injection system appears to have the potential to revolutionise LPG installations in EFI cars. The system is currently being fitted at a cost of $2500, which is claimed to be only about $500 more expensive than a conventional system. At this stage, it appears that just a little more development should result in an excellent system.

For further information on the Liquiphase LPG system, contact Liquiphase Management Pty Ltd, 20/2 Gray St, Kilkenny, SA 5009. Phone (08) 345 3500; fax (08) 347 3240. **SC**

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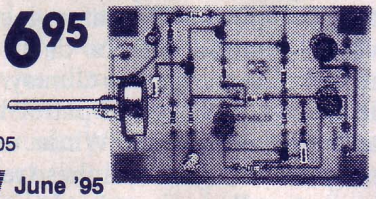

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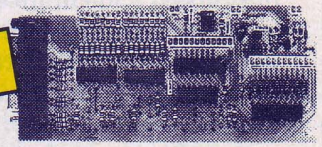

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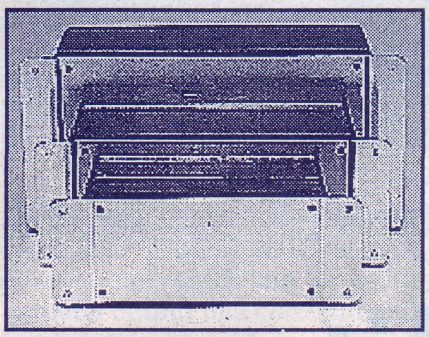

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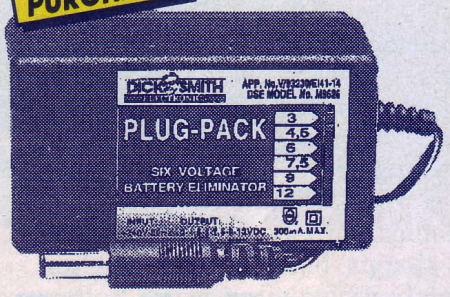

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Build this satellite TV receiver; Pt.2

This satellite TV receiver is based on a pre-aligned module. By combining it with a dish antenna & an LNB, you can receive many of the satellite TV signals (both C & K-band) that are available in this part of the world.

By JOHN CLARKE

Last month, we looked at the basics of satellite TV reception and described the equipment needed for a complete ground station. As shown in Fig.7 of that issue, a ground station consists of a parabolic dish antenna, a low noise block (LNB) downconverter, a satellite receiver and a TV set.

The satellite receiver is the one item amongst this equipment that can be easily constructed at home. This particular unit is based on a pre-built receiver module that comes fully aligned. All you have to do is add a few ancillary circuits plus a power supply and install the bits in a case.

In operation, the receiver is used to tune the signals from the LNB. What happens is that the incoming satellite signal is first collected by the dish antenna and directed to a dipole antenna in the LNB via a waveguide, after which it is amplified and downconverted. Downconversion simply refers to the fact that the incoming satellite frequency (either in the range from 3.7-4.2GHz or 12.25-12.75GHz) is converted to a much more manageable signal in the range from 950-1450MHz. It is this range of frequencies that are tuned by our satellite receiver.

Fig.8 shows the block diagram of the pre-built receiver module. It utilises a tuner module which initially amplifies and filters the IF signal from the LNB. This signal is then fed to a mixer stage where it is mixed with the signal from a varicap tuned local oscillator for second conversion to 479.5MHz. The "tuned" signal is then fed via a bandpass filter and two further amplifier stages to a PLL demodulator.

This demodulator stage produces a "baseband" output which contains both video and audio information. Composite video and audio output signals are then recovered using separate demodulator stages. These signals can be fed direct to a video monitor and audio amplifier.

In addition, the composite video

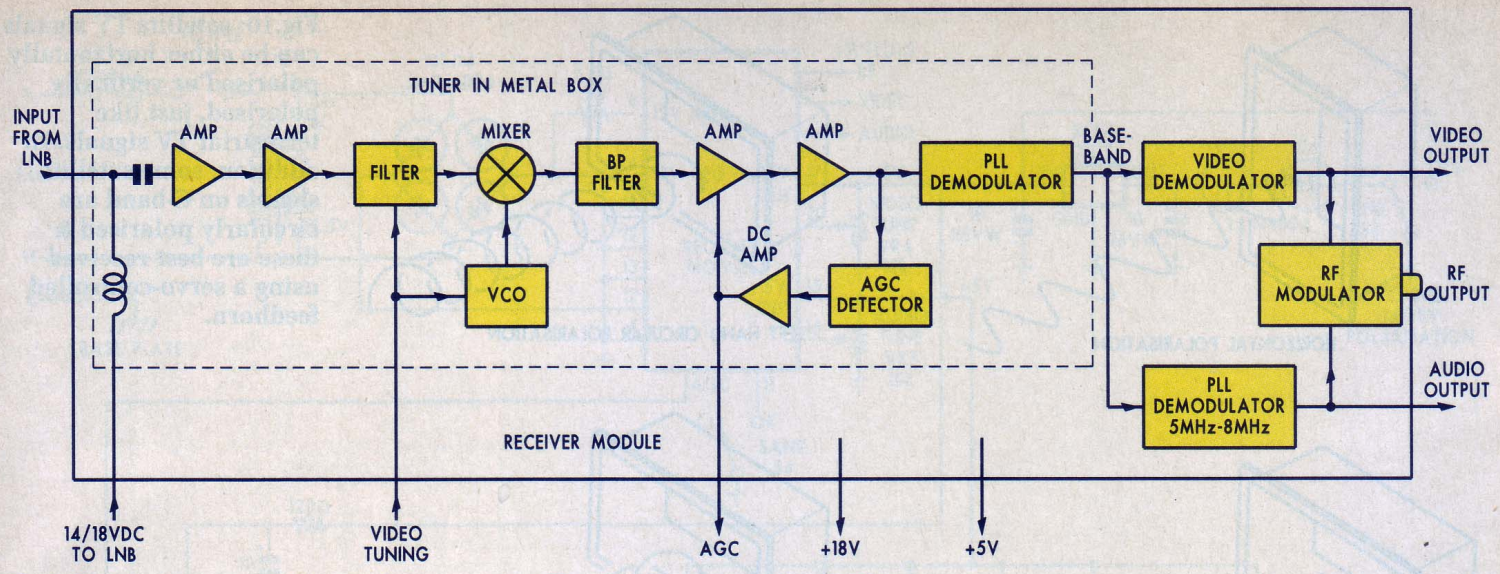


Fig.8: block diagram of the receiver module. The IF signal from the LNB is amplified & then mixed with the signal from a VCO for second conversion to 479.5MHz. The "tuned" signal is then fed via a bandpass filter & two further amplifier stages to a PLL demodulator. Composite video & audio output signals are then recovered using separate demodulator stages.

and audio output signals are fed to an RF modulator stage. This then provides an output which can be fed to the antenna output of a conventional TV receiver tuned to either channel 3 or channel 4.

Block diagram

Fig.9 shows the block diagram of the complete receiver. The pre-built module forms the heart of the design, with the extra circuitry all on an auxiliary PC board which you assemble yourself. This second board carries the IF (video) and audio subcarrier tuning controls, the band switching, the LNB polarisation circuitry, the skew controls, and the metering and power supply circuitry. The two boards are then linked using ribbon cable and connectors.

The rear panel of the receiver carries an IF input socket (to accept the signal from the LNB) plus the following outputs: VHF Out (this goes to the antenna socket of a TV receiver), Audio Out, Video Out and Skew Out. A small slider switch is also provided so that either channel 3 or channel 4 can be selected for VHF Out.

To cater for the different equipment available on the market, we have included both "dual polarity switching" and mechanical feedhorn "skew" functions in the receiver. Let's take a closer look at what these terms mean.

As with terrestrial TV signals, satellite TV signals are polarised to minimise interference between adjacent frequencies. This means that the dipole antenna in the LNB must be oriented to match the polarity of the incoming signal – ie, horizontal for horizontally-polarised signals and vertical for vertically-polarised signals (see Fig.10).

Although this could be achieved by physically rotating the LNB, it is hardly a convenient solution. Fortunately, the answer to this problem is quite simple and two methods are commonly employed.

The first method involves fitting the LNB with two dipole antennas mounted 90° apart – one horizontal and the other vertical. Either one of these dipoles can then be selected at will (using electronic switching) to match the signal polarisation. In prac-

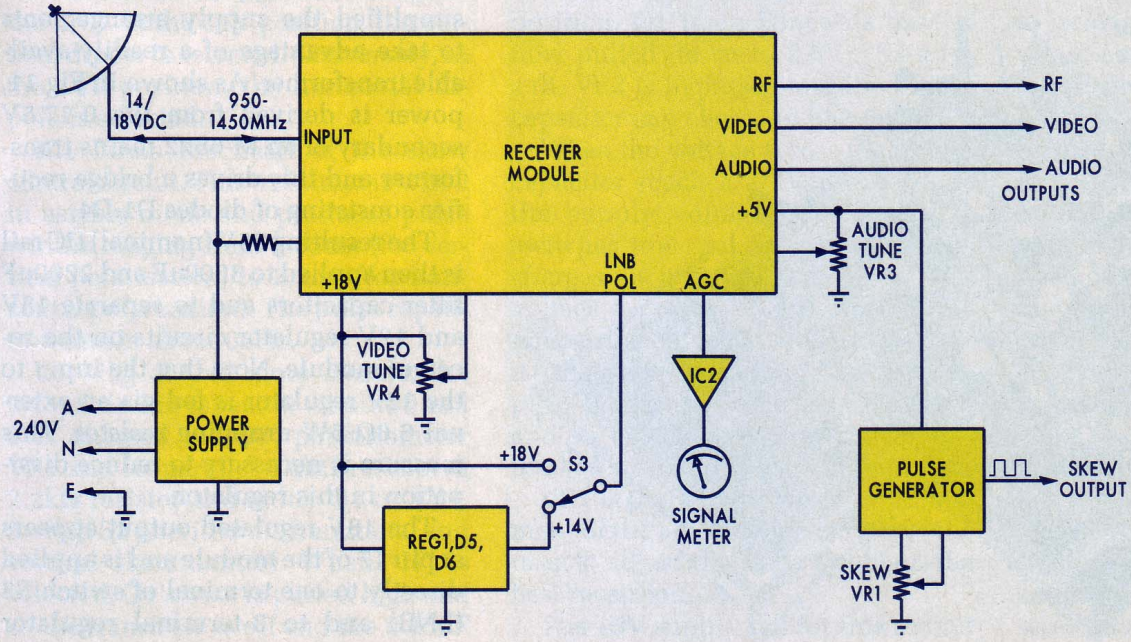


Fig.9: this is the block diagram for the complete receiver. It's based on the pre-built receiver module & adds in the necessary power supply circuitry, the tuning controls, a signal strength meter & the skew control circuitry.

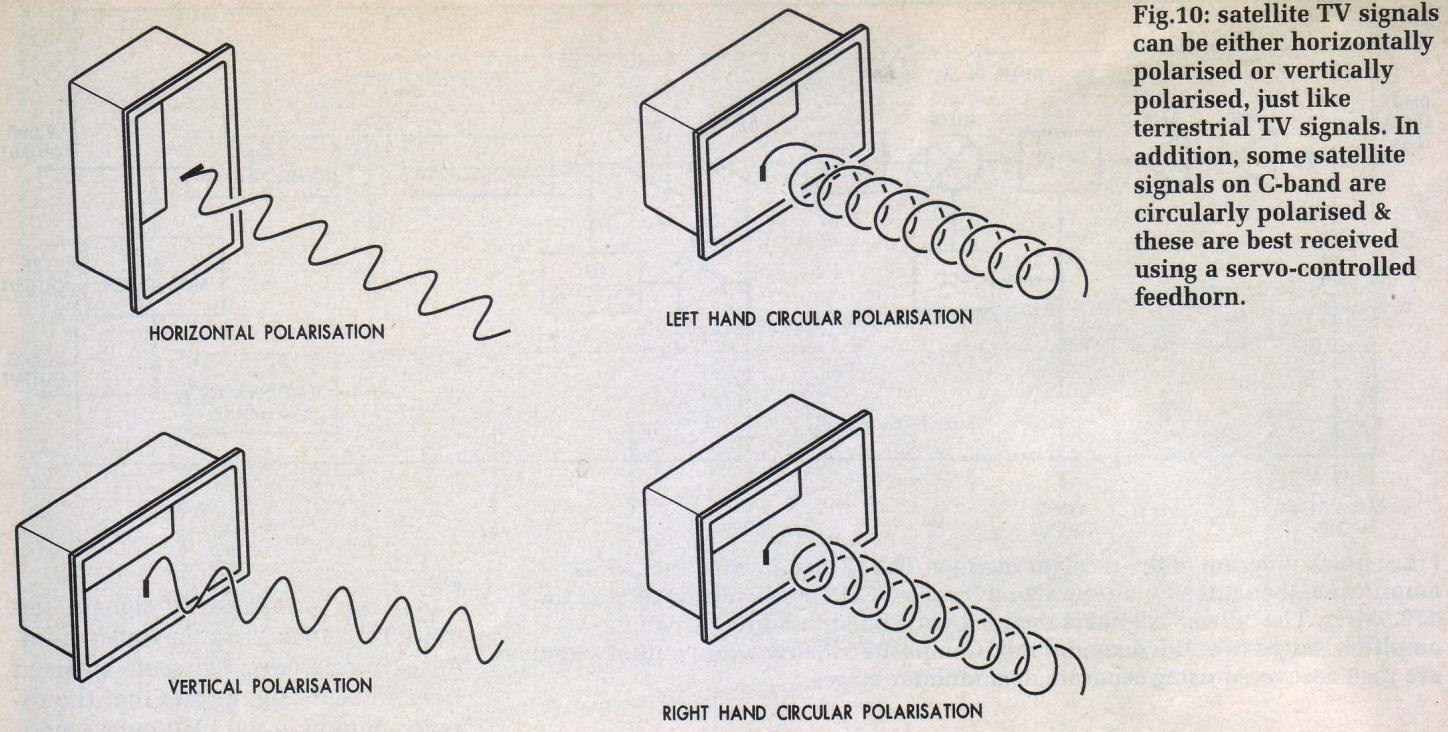


Fig.10: satellite TV signals can be either horizontally polarised or vertically polarised, just like terrestrial TV signals. In addition, some satellite signals on C-band are circularly polarised & these are best received using a servo-controlled feedhorn.

tice, this is achieved by selecting between two DC voltages (either 14V or 18V) and feeding this back up the coaxial cable to the LNB, where the dipoles are selected using diode switching.

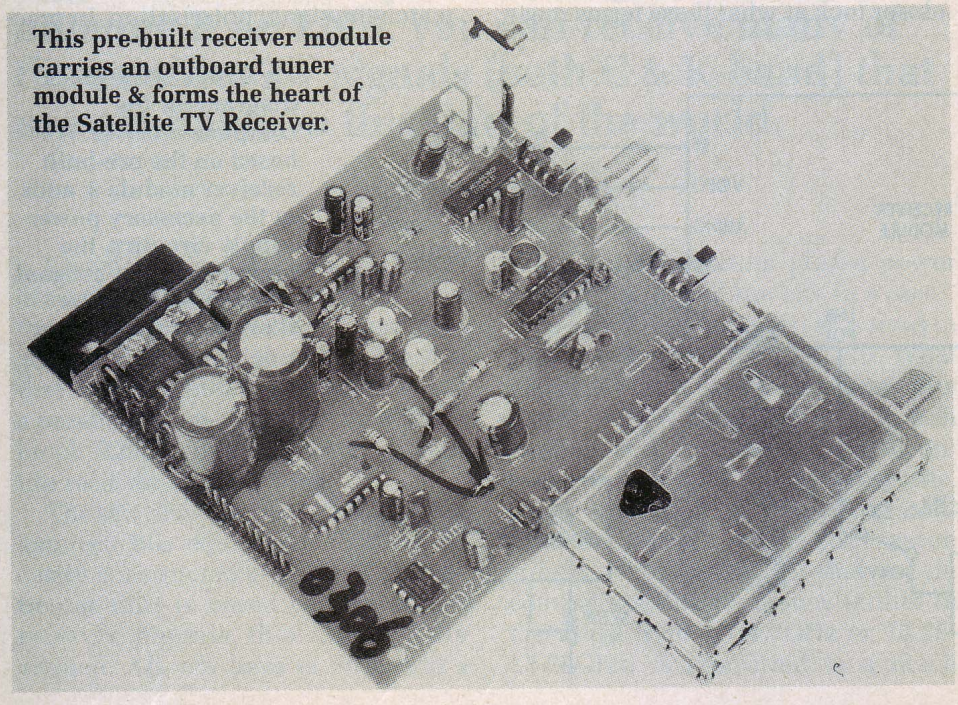
This "dual-polarity" type of LNB is used primarily for receiving linear signals (ie, signals that are either horizontally or vertically polarised) on both C-band and K-band.

However, a complication arises when we wish to also receive circularly polarised signals. These signals can be either lefthand or righthand circularly polarised (see Fig.10) and, in this part of the world, are transmitted only on C-band.

To cater for these signals, a servo-controlled feedhorn is often used. This type of feedhorn employs a digital proportional servo motor which rotates a probe through an angle of about 200° inside the waveguide. This probe is mutually coupled to a dipole antenna and is oriented using the skew controls for best signal pick-up.

In operation, the servo motor requires +5V and ground connections, plus a continuous "pulse" (Skew Out) signal. The servo motor then "skews" to an angle that's dependent on the width of the pulses.

The Skew switch and Skew Adjust control on the front panel set the pulse width and thus the angle of the probe in the feedhorn. Either horizontal (H) or vertical (V) orientation is initially selected using the Skew switch, while the Skew adjust control allows the probe to be rotated to suit the signal.



This pre-built receiver module carries an outboard tuner module & forms the heart of the Satellite TV Receiver.

Circuit details

Fig.11 shows the final circuit details of the Satellite TV Receiver.

The receiver module is nominally designed to accept centre-tapped 23V and 15V AC supply rails but we've simplified the supply arrangements to take advantage of a readily-available transformer. As shown in Fig.11, power is derived from the 0-17.5V secondary of an M-6672 mains transformer and this drives a bridge rectifier consisting of diodes D1-D4.

The resulting 25V (nominal) DC rail is then applied to 3300µF and 2200µF filter capacitors and to separate 18V and 12V regulator circuits on the receiver module. Note that the input to the 12V regulator is fed via an external 6.8Ω 5W dropping resistor. This measure is necessary to reduce dissipation in this regulator.

The 18V regulated output appears at pin 17 of the module and is applied directly to one terminal of switch S3 (LNB) and to 3-terminal regulator

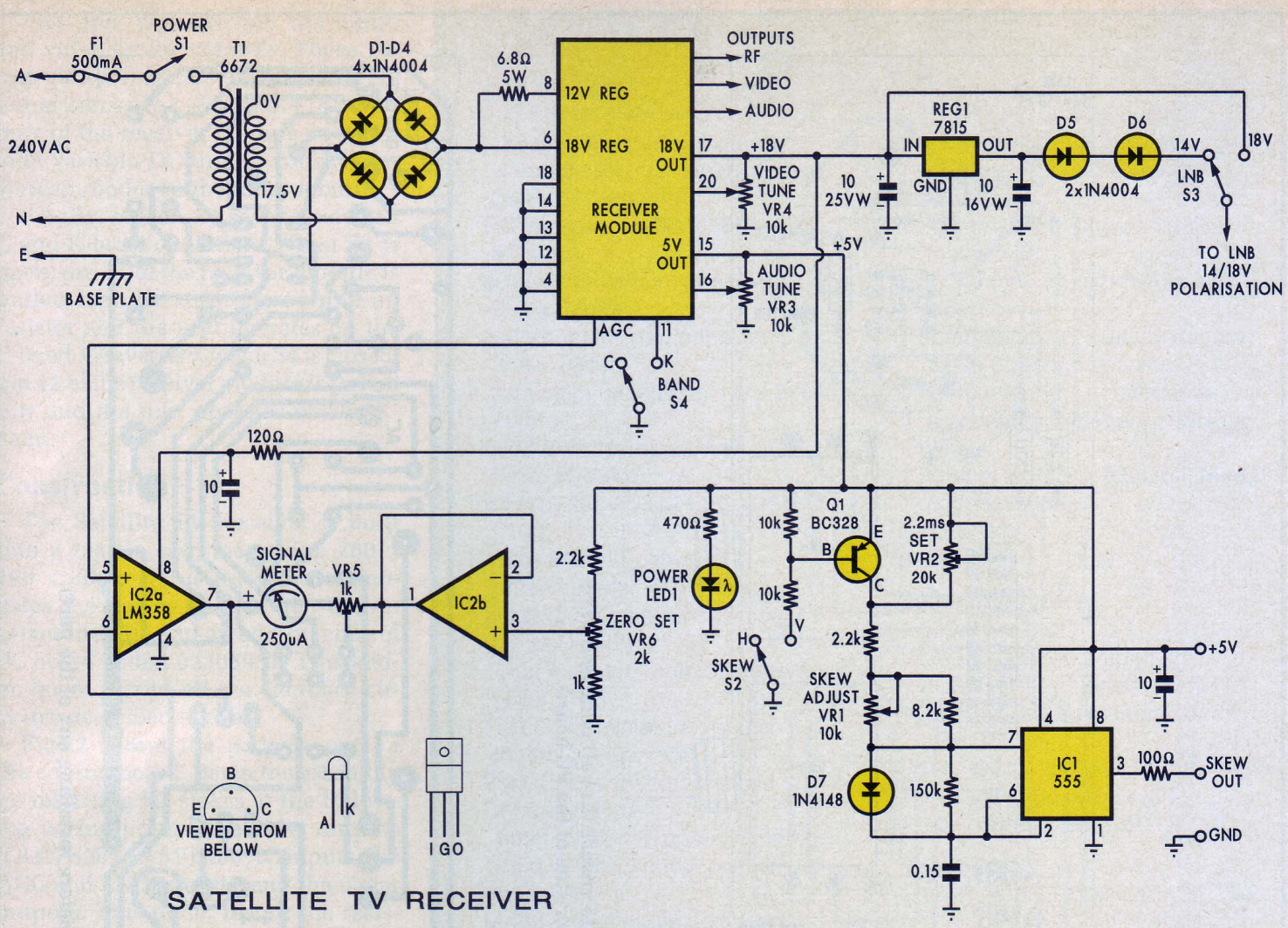


Fig.11: this is the complete circuit for the Satellite TV Receiver. Q1 & 555 timer IC1 provide the skew pulses, while IC2a buffers the AGC line to drive the signal strength meter. IC2b & VR6 provide a no-signal DC offset adjustment so that the meter can be zeroed, while VR5 sets the meter sensitivity.

REG1. The resulting 15V output from REG1 is then fed to the 14V terminal of S3 via dropping diodes D5 and D6.

As a result, S3 selects either 18V or 14V and feeds the selected voltage to the LNB. In the 14V position, the vertical dipole is selected. Conversely, in the 18V position, the horizontal dipole is selected.

IC1 forms the heart of the skew control circuit. This 555 timer is wired in astable mode and produces pulse widths ranging from 0.65ms (for vertical polarisation) to 2.2ms (for horizontal polarisation). The pulse repetition rate is about 66Hz.

Looking at this more closely, the 0.15µF timing capacitor on pins 6 and 2 is charged via D7, potentiometer VR1 and its parallel 8.2kΩ resistor, a 2.2kΩ resistor and either Q1 or VR2. Switch S2 provides the horizontal and vertical skew control. When "H" is selected, Q1's base is pulled high and so the transistor is off and the 0.15µF capacitor charges via trimpot VR2 to give a nominal 2.2ms charging time. During this time, IC1's pin 3 output is high.

Conversely, when S2 is in the "V" position, Q1 is on (since its base is now pulled down to 2.5V). As a result, VR2 is bypassed and the timing capacitor can charge in just 0.65ms.

When the voltage across the timing capacitor reaches 2/3Vcc (ie, 2/3 of the supply voltage), pin 7 of IC1 switches low and the capacitor discharges via a 150kΩ resistor until its voltage drops to 1/3Vcc. During this period, the output at pin 3 is also low. At the end of the discharge period, pin 7 (and pin 3) switches high again and so the cycle is repeated indefinitely for as long as power is applied.

VR1 is there to provide fine adjustment of the skew. This pot allows the user to adjust the skew to obtain the best reception.

The +5V supply rail for this circuit comes from a regulated output on the receiver module. This supply rail is also applied to LED 1 via a 470Ω current limiting resistor to provide power on/off indication.

Signal strength meter

The AGC (automatic gain control) line from the receiver module is used to provide a measure of the tuned signal strength. This line drives the signal meter via op amp IC2a which is wired as a unity gain buffer stage.

In addition, the no-signal DC offset of the AGC line is nulled using trimpot VR6. This trimpot applies a preset voltage (derived from the 5V rail) to pin 3 of unity gain buffer IC2b, which then drives the negative side of the meter via trimpot VR5.

In practice, VR6 is adjusted during the calibration procedure so that the meter reads zero under no signal conditions. It simply sets IC2b's output to the same level as IC2a's output, so that 0V appears across the meter.

VR5 sets the meter sensitivity. It is adjusted so that the meter reads full-scale on a powerful signal.

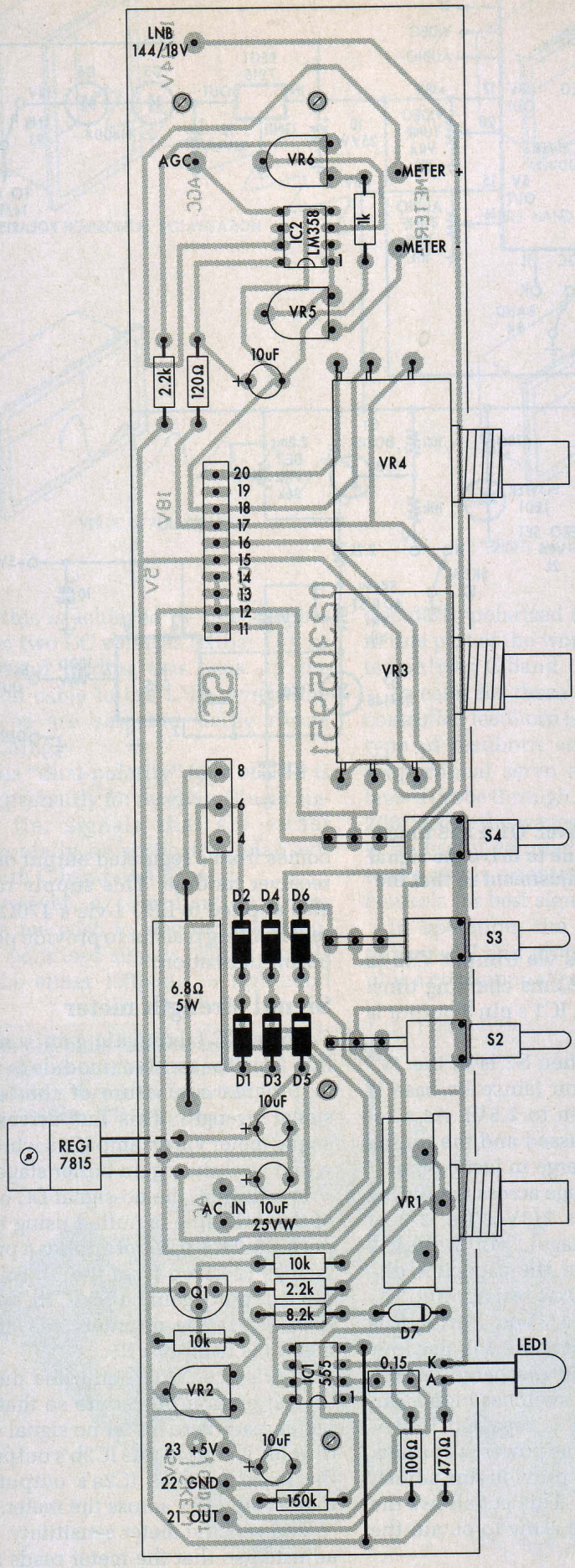


Fig.12(a): install the parts on the control board as shown here, taking care to ensure that all polarised parts are correctly oriented. Note that regulator REG1 is installed from the copper side of the PC board.

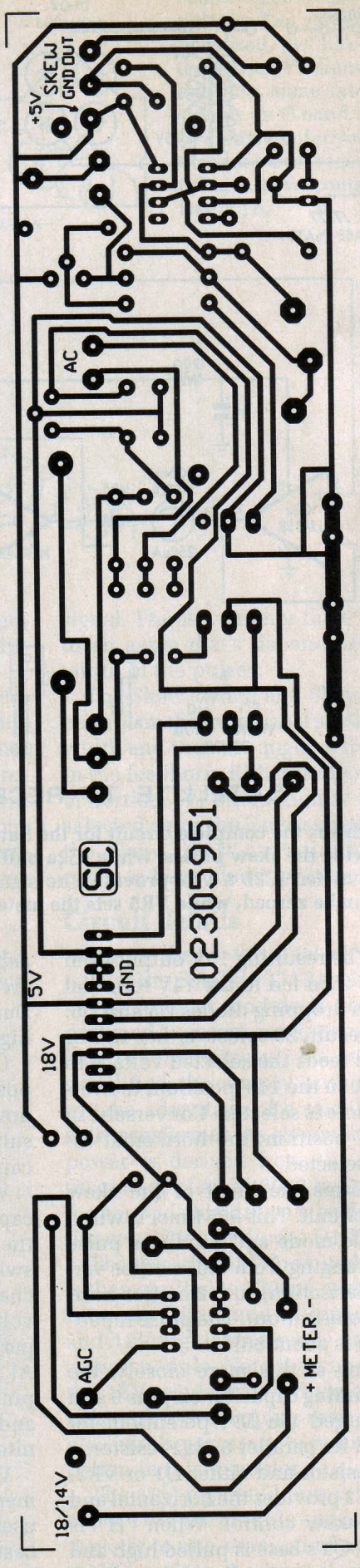


Fig.12(b): check your board carefully against this full-size etching pattern before installing any of the parts.

VR3 and VR4 provide the audio and video tuning controls. These 10-turn potentiometers are respectively wired across the +5V and +18V outputs of the receiver module and provide variable DC tuning voltages for varicap diodes in the tuner module.

Finally, switch S4 selects between C and K band operation. When S4 is open, pin 11 of the receiver module is pulled high by an on-board pull-up resistor and the unit operates on the C-band. Conversely, when S4 is closed, pin 11 of the receiver module is pulled low and the unit operates on the K-band.

Construction

The Satellite TV Receiver is built into a plastic case measuring 260 x 190 x 80mm. This easily accommodates the power transformer, the receiver module and an add-on control PC board coded 02305951. This add-on board carries all the ancillary circuitry described above.

Fig.12 shows the parts layout on the control board. Begin the assembly by installing PC stakes at the following wiring points: the skew outputs (OUT, GND & +5V), the AC inputs, the AGC and LNB outputs, and the meter outputs. This done, install the resistors and capacitors, followed by the ICs, diodes and the transistor.

Table 1 shows the resistor colour codes but it is also a good idea to check each value using a digital multimeter, as the colours can sometimes be difficult to decipher. Note that the 6.8Ω 5W resistor should be mounted about 2mm above the board surface to allow the air to circulate beneath it for cooling (this resistor runs hot).

Note also that D7 is a small signal diode while diodes D1-D6 are all 1A rectifier types.

The trimpots can be installed now. Take care to ensure that the correct value is installed at each position (VR2 = 20kΩ; VR5 = 1kΩ; and VR6 = 2kΩ).

PARTS LIST

1 satellite receiver module (Av-Comm)
1 vented plastic instrument case, 260 x 190 x 80mm
1 PC board, code 02305951, 233 x 51mm
1 self-adhesive front panel label, 254 x 73mm
1 self-adhesive rear panel label 254 x 73mm
1 aluminium baseplate, 1.5 x 220 x 90mm
1 6672 30V 1A transformer (T1) (DSE M-6672)
1 level meter, 250µA FSD (DSE Q-2100)
1 10kΩ 24mm PC-mount potentiometer (VR1)
1 20kΩ (203) miniature vertical trimpot (VR2)
2 10kΩ multi-turn potentiometers (VR3,VR4)
1 1kΩ (102) miniature vertical trimpot (VR5)
1 2kΩ (202) miniature vertical trimpot (VR6)
1 15mm knob with position marker
2 15mm knobs without position markers
1 M-205 panel mount fuseholder
1 500mA M-205 fuse (F1)
1 mains cord with moulded plug
1 cordgrip grommet to suit mains cord
1 SPDT mains rocker switch (S1)
3 SPDT right-angle PC mounting switches (S2-S4) (DSE P-7686)
1 3mm LED bezel
5 6mm PC board standoffs
1 9mm standoff
1 10-way pin header socket
1 5-way pin header socket
1 6.5mm stereo panel socket
3 solder lugs
1 300mm length of green/yellow mains wire
1 300mm length of brown mains wire
1 50mm length of 10-way rainbow cable (2.54mm spacing)
3 500mm lengths of different coloured medium-duty hook-up wire
1 200mm length of 0.8mm tinned copper wire
9 PC stakes
6 cable ties

Semiconductors
1 555 timer (IC1)
1 LM358 dual op amp (IC2)
1 BC328 PNP transistor (Q1)
1 7815 1A 3-terminal regulator (REG1)
6 1N4004 1A diodes (D1-D6)
1 1N4148 signal diode (D7)
1 3mm green LED (LED1)

Capacitors
1 10µF 25VW PC electrolytic
3 10µF 16VW PC electrolytic
1 0.15µF MKT polyester

Resistors (0.25W, 1%)

1 150kΩ	1 1kΩ
2 10kΩ	1 120Ω
1 8.2kΩ	1 100Ω
2 2.2kΩ	1 6.8Ω 5W WW

Miscellaneous
Heatshrink tubing, machine screws, nuts, lockwashers.

The resistance codes for these pots are shown in the parts list.

Next, install the Skew Adjust pot (VR1), switches S2-S4 and LED 1. The LED should be mounted at full lead length so that it can later be pushed into its bezel on the front panel. Watch the orientation of the LED – the anode lead is the longer of the two.

The two multi-turn pots (VR3 &

TABLE 1: RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	150kΩ	brown green yellow brown	brown green black orange brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	1	8.2kΩ	grey red red brown	grey red black brown brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	120Ω	brown red brown brown	brown red black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown

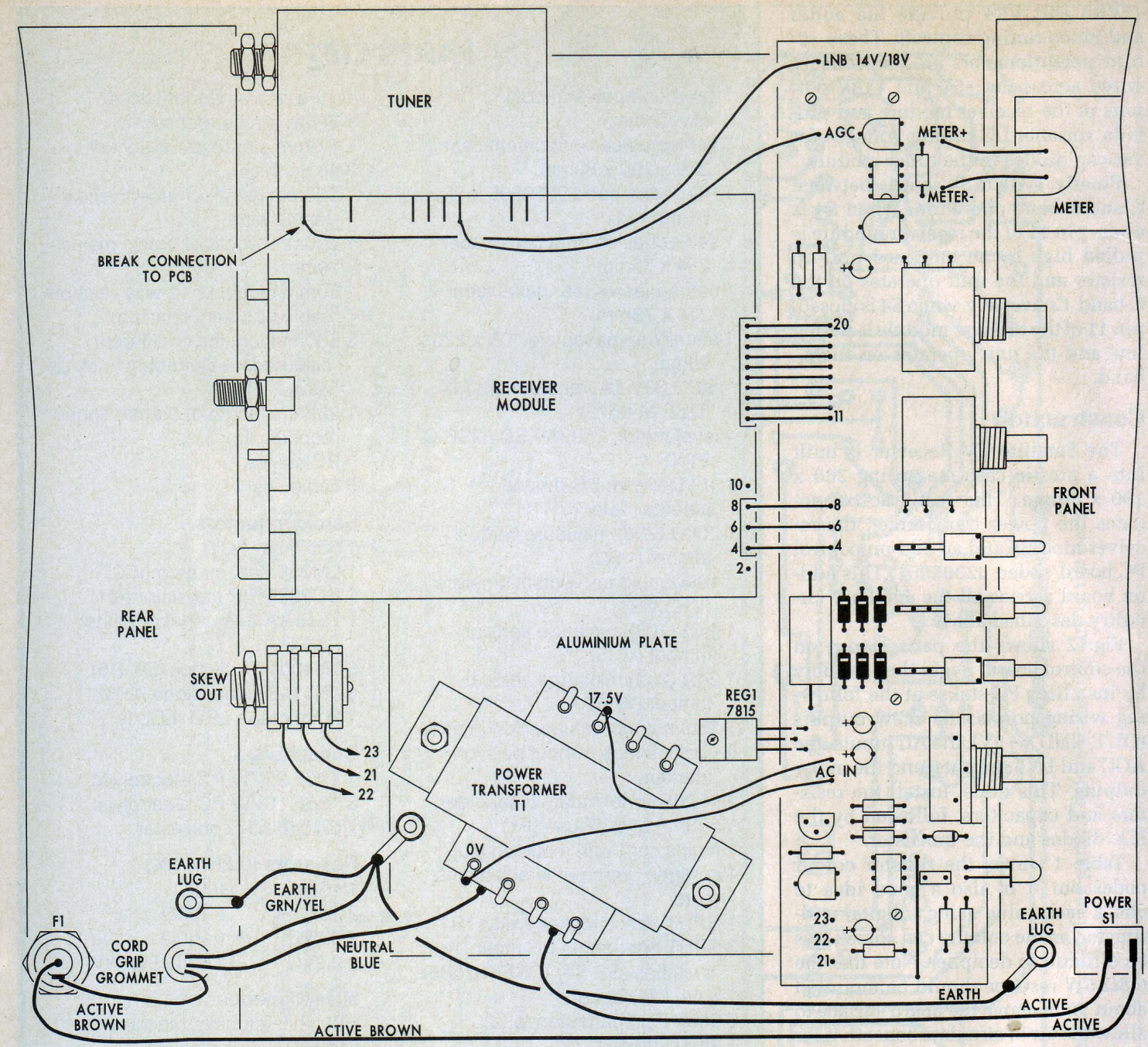


Fig.13: the transformer is mounted in the case on an aluminium plate which must be securely earthed – see text. Be sure to use mains-rated cable for all mains wiring & cover all exposed terminals with heatshrink tubing.

VR4) are connected to the board via short lengths of tinned copper wire. At this stage, just install 25mm lengths of wire into their terminal holes on the PC board but leave the pots to one side for the time being.

The 3-terminal regulator (REG1) is installed on the underside of the PC board (see photo), so that it can later be bolted to an aluminium plate. This aluminium plate is fastened to the base of the case and, in addition to supporting the power transformer, also provides heatsinking for the three regulators on the receiver module.

Before installing the regulator, bend its leads through 90° so that they mate with its mounting holes in PC board. This done, push the leads through the board (from the copper side) and adjust the regulator so that its top surface sits about 1mm below the bottom of the PC board, then solder its leads – see Fig.13.

The PC board assembly can now be completed by soldering a 50mm length of 10-way rainbow cable to points 11-20, followed by three 50mm lengths of hook-up wire to points 4, 6 & 8. The free ends of these leads are then terminated in pin header sockets. This simply involves lightly soldering each lead to a pin and then pushing the pins down into the socket until they lock in position.

Take care when connecting the leads from points 4, 6 & 8 to their header socket. Assuming the use of a 5-way header socket, these leads should go to the two outside pins and to the centre pin, so that they mate with points 4, 6 & 8 on the receiver module.

Case preparation

The next step is to drill the case so accept the various hardware items. This job can be made easy by first affixing the front and rear panel adhesive labels to the plastic panels. This done, the labels can then be used as drilling templates.

Don't try to drill large holes in these panels. Instead, it's best to first drill a small pilot hole and then enlarge this carefully using a tapered reamer until the relevant part is an exact fit.

The cutouts for the meter and power switch can be made by first drilling a series of small holes around the inside perimeters of the rectangles. The centre pieces are then knocked out and the cutouts filed to the correct shape. Both the meter and the switch should be a tight fit in these cutouts. The rectangular holes in the rear panel for the two slider switches are made in similar fashion.

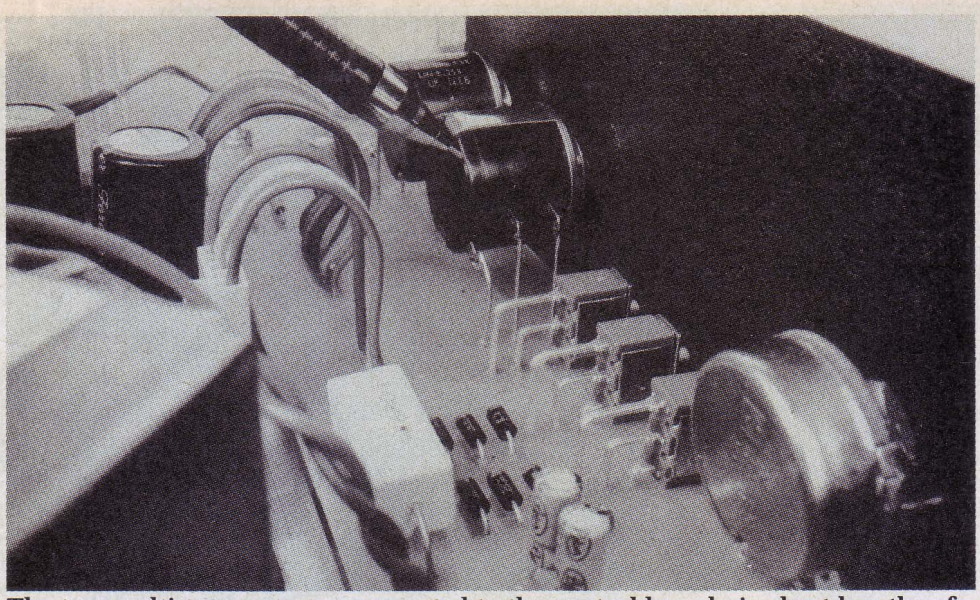
The hole positions for the earth screw, fuseholder and mains cord grommet are indicated by crosses on the righthand side of the rear panel. Note that the hole for the cordgrip grommet should be carefully shaped to suit, so that the grommet will later securely clamp the mains cord without any risk of it pulling out of the panel.

The adhesive labels for the front and rear panels are made from aluminium and must be earthed to ensure electrical safety. Make sure that the earth screws make electrical contact with the panels by scraping away the top layer to expose the aluminium around the hole.

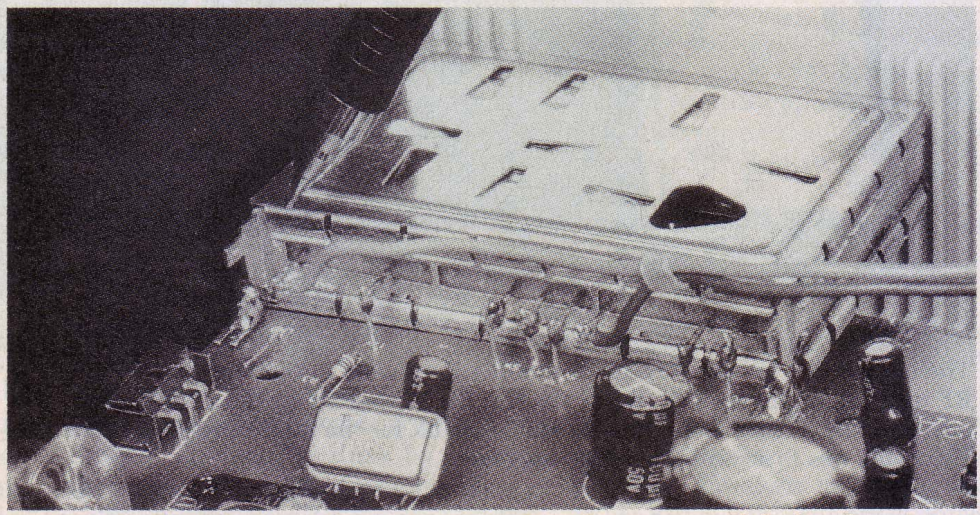
Once the holes have been drilled, fit the front panel to the control board by slipping it over the threaded bushes of the toggle switches and the Skew Adjust pot. Note that the latter is secured using a nut on either side of the panel. The control board, along with the front panel, is then mounted in the case on five 6mm-long standoffs. These standoffs in turn sit on integral mounting bushes moulded into the base and the whole assembly is secured using self-tapping screws.

If necessary, use adhesive tape to hold the standoffs in position while the control board is positioned over them and the screws installed.

The power switch, signal strength meter and multi-turn pots can now be mounted on the front panel, along with the earth solder lug. Use a round-head screw and two starwashers (one under the head of the screw and the other under the nut) to secure the earth lug and make sure that the assembly is tight. Finally, check that the front panel is indeed electrically connected to the earth lug by checking for continuity with your multimeter.



The two multi-turn pots are connected to the control board via short lengths of tinned copper wire, while the 5W wirewound resistor in the foreground should be mounted about 2mm above the board surface so that the air can circulate beneath it for cooling. Note that this resistor normally runs hot.



The existing link between the LNB terminal on the tuner module (ie, the one nearest the rear panel) & the receiver board must be removed. This can be done by cutting the top of the link with a pair of side cutters & bending it down onto the PC board so that it is out of the way.

Next, install the LED bezel and push the LED into it (bend the LED leads at right angles). The front panel assembly can then be completed by wiring VR3, VR4 and the signal strength meter. A small amount of epoxy adhesive can be used to secure the meter.

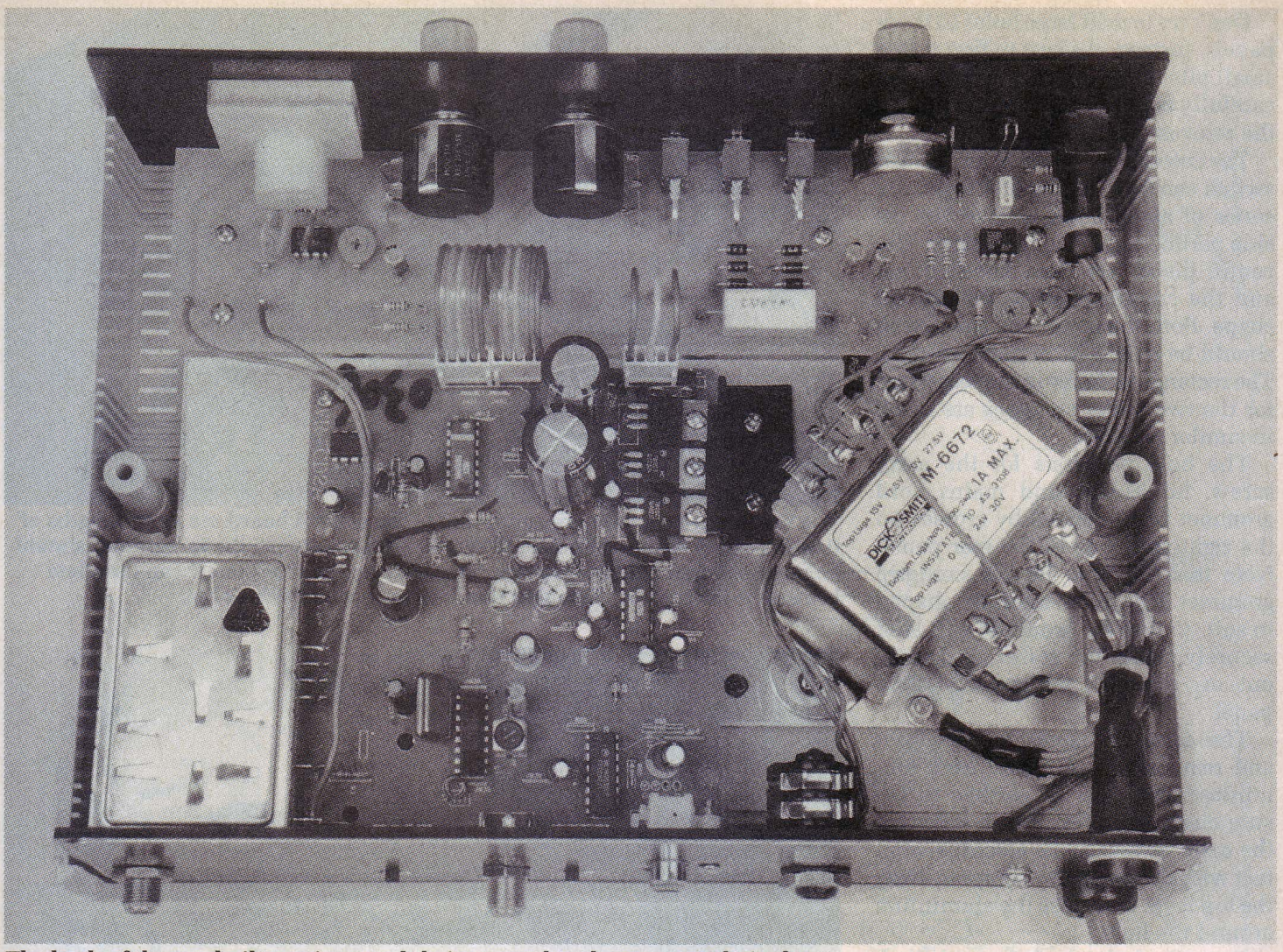
Moving now to the rear panel, begin by installing the fuseholder and the earth lug in their designated positions. As before, use star washers under the head of the earth screw and under the nut, and use your multimeter to check for electrical continuity between the lug and the panel after the screw has been tightened.

This done, the mains cord can be passed through its access hole and securely clamped using the cordgrip grommet. Strip back the outer sheath of the mains cord by about 80mm so that you are ready to make the necessary connections later on.

The receiver module (with its attached tuner) can now be attached to the rear panel. It is fastened by doing up the nuts on the two RF sockets (IF IN & VHF OUT) and by installing a small screw and nut adjacent to the audio and video RCA sockets. Check that the two slider switches operately freely when this has been done, then fit the 6.5mm stereo panel socket (Skew Out).

Drilling the baseplate

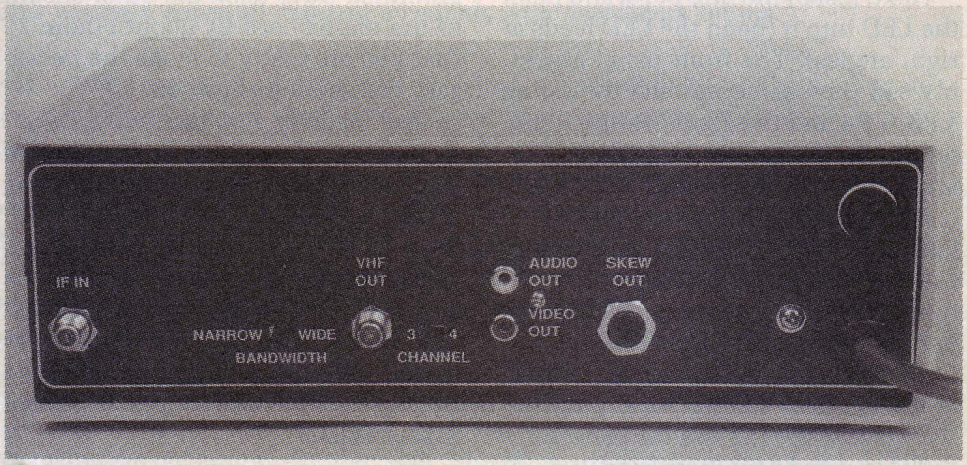
The aluminium baseplate measures 220 x 90mm and is positioned so that



The back of the pre-built receiver module is secured to the rear panel via the RF input & output sockets, while the front is supported on the aluminium baseplate by a 9mm standoff & by the heatsink for the 3-terminal regulators. Use cable ties to secure the mains wiring.

its front edge lines up with the rear of the control board. You will have to mark out and drill four or five holes in this baseplate so that it can be fastened using self-tapping screws to the integral mounting posts moulded into the case.

After drilling these holes, temporarily fasten the baseplate using a couple of screws, then install the rear panel with its attached receiver module. The following mounting holes should now be marked on the baseplate: (1) two holes for the heatsink fitted to the regulators; (2) a hole for regulator REG1; (3) a corner mounting hole for the receiver module at front right (ie, near the 8-pin IC); (4) two holes for the power transformer (use the transformer as a template); and (5) a hole for an earth solder lug – see Fig.13.



The rear panel of the receiver carries an input socket to accept the signal from the LNB plus the following outputs: VHF Out, Audio Out, Video Out & Skew Out. A small slider switch is also provided so that either channel 3 or channel 4 can be selected for VHF Out.

The baseplate can now be removed from the case and the various holes drilled. This done, smear the mating surface of the heatsink with heatsink compound and bolt it to the baseplate using machine screws, nuts and washers. Similarly, secure the power transformer and the earth solder lug to the baseplate.

The front corner of the receiver module is supported on a 9mm standoff and is fastened with a screw, nut and lockwasher.

The entire assembly – consisting of the baseplate, transformer, receiver module and rear panel – can now be

installed in the case. Note that it may be necessary to temporarily loosen the mounting screws for the control board so that the baseplate can be slid under REG1. Use self-tapping screws to secure the baseplate to the integral standoffs moulded into the base and be sure to re-tighten the mounting screws for the control board.

It will be necessary to drill a hole through the bottom of the case to install the mounting screw for REG1. Measure out and mark the position of this hole carefully prior to drilling, to ensure that it is directly in line with the mounting hole in the baseplate. Note that REG1 can be directly bolted to the baseplate without an insulating washer.

Final wiring

Refer to Fig.13 for the final wiring details. Take care with the mains wiring – the Active (brown) lead from the mains cord goes to the fuseholder, while the Neutral (blue) lead goes direct to one of the transformer primary terminals. The other side of the fuseholder goes to the power switch (S1), with a further lead then running from S1 back to the remaining transformer primary terminal.

Be sure to use mains-rated 250VAC cable for the connections to the power switch and for the mains earth wiring. In addition, heatshrink tubing should be used to cover the fuseholder and the mains switch connections – see photo. This involves slipping suitable lengths of heatshrink tubing over the leads before they are soldered to these parts. After soldering the leads, push the heatshrink tubing over the switch and fuseholder and shrink it down with a hot-air gun.

Similarly, sleeve the transformer primary connections with small diameter heatshrink tubing to avoid the possibility of accidental electric shock from otherwise exposed terminals.

The Earth lead (green/yellow) from the mains cord connects directly to the earth lug on the aluminium baseplate. Additional earth leads are then run from this point to the earth lugs on the front and rear panels. Use cable ties to secure the mains wiring, so that there is no danger of contact with low voltage circuitry should a lead come adrift.

Medium-duty hook-up wire can be used for the low-voltage wiring. This involves the transformer secondary connections, three connections to the Skew Out socket, and two connections from the control board to the tuner module (LNB & AGC). Twist the leads to the Skew Out socket together and lace the leads to the tuner module to keep them tidy – see photos. The transformer secondary leads should also be twisted together.

Note that the existing connection between the LNB terminal on the tuner module (ie, the one nearest the rear panel) and the receiver board must be broken. This can be done by cutting the wire with a pair of side cutters.

Finally, connect the header sockets to the receiver module and fit the knobs to the control pots.

Test & adjustment

Before applying power, go back over your work carefully and check that all the wiring is correct. In particular, check the mains wiring carefully and check that the front and rear panels have been properly earthed.

Now apply power and check that the power LED lights. If it does, check the output voltages from REG1 and the three regulators on the receiver module. REG1 should have an output of 15V, while the other three regulators should have outputs of 18V, 12V and 5V (you should get readings within 10% of these nominal voltages).

Note that the 14V rail for the LNB (ie, the cathode of D6) will not necessarily read 14V until a load is connected to this output. Assuming that all is well, adjust trimpot VR6 so that the meter reads zero.

If an oscilloscope is available, use the following procedure to adjust trimpot VR2 to obtain the correct skew pulse widths:

(1) Connect the oscilloscope probe to the skew output (pin 21 on the control board);
(2) Set the Skew Adjust pot (VR1) to mid-position and the Skew switch (S2) to horizontal (H);
(3) Adjust VR2 until the skew pulses are 2.2ms wide;
(4) Flick the Skew switch to vertical (V) and check that the skew pulses are now 0.65ms wide

If you don't have an oscilloscope, use the following procedure to adjust VR2 instead:

(1) set VR1 to mid-position, S2 to "H" and temporarily connect a 47kΩ pull-up resistor between the skew output and the +5V rail;
(2) Connect a multimeter between the skew output and ground;
(3) Adjust VR2 for a DC reading of 618mV (note: this is an average reading of the skew pulses)
(4) Flick S2 to "V" and check that the meter now reads about 200mV DC;
(5) Remove the 47kΩ pull-up resistor.

That completes the adjustment procedure. The unit can now be tested for proper operation by setting it up with a dish, an LNB and a TV set. We'll cover that procedure and describe how the unit is used next month. SC

Where To Buy The Parts

A short-form kit for the Satellite TV Receiver is available from Av-Comm Pty Ltd. This kit (Cat K-1000) is priced at $150 & includes the receiver module, an etched PC board (code 02305951), two 10-turn 10kΩ pots, the aluminium baseplate (undrilled) & the front & rear panel labels. The case, meter, power transformer, control-board components & other minor parts are not included & will have to be purchased separately from parts retailers.

In addition, Av-Comm is offering the following packages to SILICON CHIP readers at special prices:

(1) For K-band reception: 1.6-metre dish with ground mount stand, dual-polarity LNB, 25 metres RG-6/U coaxial cable & K-1000 short-form Satellite TV Receiver kit (see above). Price $684.00.

(2) For C-band reception: 3-metre dish with tracking mount, servo-controlled feedhorn, 20°K (noise temperature) C-band LNB, 25 metres RG-6/U coaxial cable & K-1000 short-form Satellite TV Receiver kit (see above). Price: $2092.00.

For further information, contact Av-Comm Pty Ltd, 198 Condamine St (PO Box 225), Balgowlah, NSW 2093. Phone (02) 949 7417; fax (02) 949 7095.

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Regards, **Jack O'Donnell**, Managing Director

Jack O'Donnell

Baby Room Monitor & FM Transmitter Kit

(See SC Jan '91) This monitor allows you to listen to your baby or young children from a remote location using a conventional FM receiver. It runs from a single 1.5V AA battery and includes a muting facility so that it only transmits sounds above a certain level.

K 1180 **$24.95**

Rattle the Floor Boards with this Brilliant Sub-Woofer Controller Kit

A very exciting subwoofer adaptor design soon to be published in Silicon Chip Magazine. ***High level inputs*** enables simple parallel connection to either left or right stereo speaker. ***Low level inputs*** allows connection to surround sound subwoofer output or standard stereo signal. eg CD, VCR etc. ***Other features*** of this excellent design includes: • Variable filter output frequency • Inbuilt compressor/limiter prevents over-drive clipping • Subsonic filter (below 15Hz) • Auto input signal sensing and 24V power up facility for external sub power amplifier • "In Phase" and "Out of Phase" outputs enable bridge mode output if desired. Very compact, only 200W x 160D x 70H mm. Two versions available, PCB only (K 5562), or complete with a case, power supply and PCB (K 5563).

K 5562 Short Form Version

Add Incredible Bass to Your Hi-Fi or Home Theatre System!

K 5563 Full Version

K 5562 Short Form Version (PCB Only) **$49**

M 9120 12V AC Plugpack to Suit K 5562 **$12.95**

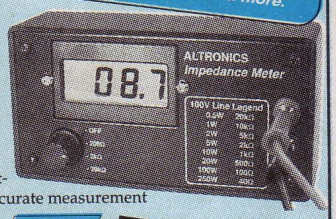
K 5563 Full Version (PCB, Case, Power Supply) **$99**

Impedance Meter Kit

Great for measuring: • Speaker impedances • Line transformer / audio transformer impedance and reflected impedance etc • Speaker circuit total impedance & more.

Our brilliant LCD Impedance Meter is now (at last!) available.

Measuring a transformer with a standard ohm meter will not give accurate results because it is measuring with a DC signal, not AC. This invaluable unit is fantastic for checking transformers and speaker impedances. For those people dealing in PA equipment, the built in tone generator enables an entire PA system to be checked before the amplifiers are connected. Uses one 9 Volt battery. (Not supplied). Three ranges enable accurate measurement of 2 - 20,000 ohms. Accuracy mid range typically ± 5%.



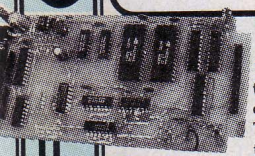
NEW

Why Pay $400 or More?

K 2550 Kit Version **$99.00**

K 2551 Fully Built & Tested Version **$159.00**

EPROM Emulator Kit



This EPROM emulator allows you to do away with EPROM's whilst in the prototyping stage of product development. The emulator is connected to a spare parallel port on your computer and also the 'target' board. The EPROM file (that is normally downloaded into the EPROM), is then transferred into the emulator by copying the file to the parallel port. This process saves repetitively "blowing" new EPROM's with each modification to the program. Emulates 2764, 27128, 27256 and 27512 EPROM's.

K 9530 **$129**

Photographic Timer Kit for Darkrooms

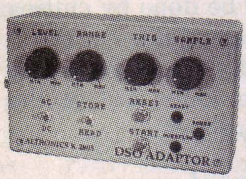
(See SC April '95) If you're looking for an accurate way to control film developing times, then take a look at this photographic timer. It will switch on mains powered fluorescent ultraviolet tubes or incandescent lamps rated at up to 1200 watts via a 3 pin mains outlet. The time can be adjusted simply with a control knob on the front panel in preset times, ranging from 1second to 450 seconds. A focus switch allows you to manually switch on the light. The timer is easily started at the press of a button.

Accurately Control Time Exposures in the Darkroom!

K 1851 **$79.00**

Digital Storage C.R.O. Adaptor for P.C.'s Kit

(See EA Jan '93) This great kit enables a P.C. user to capture a waveform and zoom in to segments of interest then save them to disc. The unit has 32K of storage memory and a sampling rate of over 600K samples per second. Input level of up to 2.5 Volt. Full sampling rate between 15K s/s to over 600K s/s. Input impedance of 1M ohm.

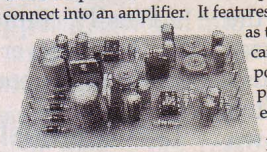


K 2805 Normally $63.50, **This Month Only $55**

K 2807 PC 3.5" Disk Software to Suit **$19.95**

Balanced Input Mic Pre-Amp Kit

(See SC April '95) This kit will amplify a microphone (low level signal) to a line level to connect into an amplifier. It features high performance with a balanced mic input as well as two auxiliary inputs which are all mixed on board. It can be configured to operate from either a single ended power supply (12V to 40V DC), or a split rail power supply (±15V to ±40V DC), making it ideal to build into any existing amplifier.



K 5531 **$27.95**

Ugly is Only Skin Deep!

Stony Broke Speaker Kit by *REDBACK*

"These have no right to sound as good as they do!" Leo Simpson, Silicon Chip Magazine.

As featured in SC Magazine June '94. This speaker kit is a bit like the Volkswagon; not too pretty to look at but performs superbly. Well that's the same as the Stony Broke speakers; pretty ugly but sounds sensational. Frankly, the reproduction from these speakers must be heard to be believed. They sound simply amazing. Ideal for bookshelf speakers, extension speakers or speakers for personal walkman type systems. Comes supplied in kit form. The kit for each speaker consists of two large jiffy boxes, one C 0629 30 Watt driver, one C 3010 tweeter, crossover, innerbond wadding, port tube, spring loaded terminals, 6 metres of cable, all fixing screws etc. In fact all you will need is a tube of silicon or similar to seal the 2 boxes together. The main speaker holes have been machined, all you will have to do is drill the mounting holes for the speakers. No special tools are required. Basically all you will need is a screwdriver, soldering iron, drill with 3mm drill bit, cutters etc. Even though these are a low cost kit, there has been a considerable amount of engineering to achieve the resultant sound! The main speaker driver complimented with the tuned enclosure exhibits quite amazing bottom end for a speaker this size.

C 3200 Only **$99.00** per pair

Digital Multimeter Kit

As Featured in Silicon Chip Magazine June 1995.

Without a doubt the trusty multimeter is the most used piece of test equipment in everyday electronics!
This fantastic meter includes all the parts required to complete a fully operational digital multimeter. Even the test leads and battery are supplied!
With proper care this quality multimeter will last for years..
Features:
• 19 ranges • Transistor tester • Diode check • 5 DC current ranges (200µA-10A) • 5 resistance ranges (200Ω-2MΩ) • 5 DC volts ranges (200mV-1000V) • 2 AC volts ranges (200V & 750V)

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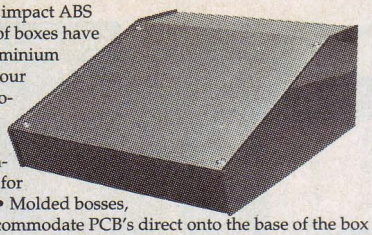

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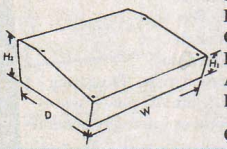

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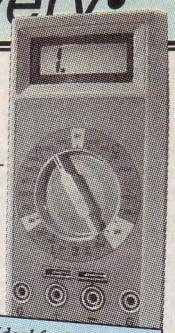

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Input Impedance:.....10MΩ
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AC Current Ranges:.....200mA, 20A
Resistance Ranges:.....200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ, 20MΩ, 200MΩ
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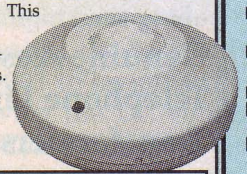

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Each includes 4 fixing clamps.

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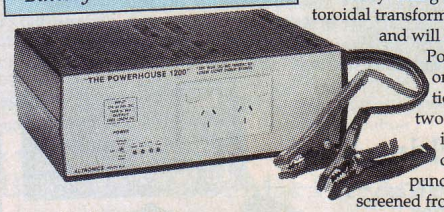

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Mystery audio stage

The Serviceman's Log article in the April 1995 edition invited readers to offer a solution to a problem of circuit theory in the audio output stage of a TV set. The circuit diagram extract was on page 56. Here are my thoughts on the matter. I agree with the Serviceman in that the IC output is at pin 3 and that feedback from the audio output goes back to pin 2 of the IC for some reason.

I am 90% certain that diode D601 is only a back-EMF surge protection (from transformer output coil) for the base junction of Q601, since the diode is reverse biased during all normal excursions of the signal. If the schematic had located the diode directly across the Q601 base junction, it would not have been so confusing a circuit.

The design is actually quite brilliant in respect to having achieved stable quiescent biasing of both Q601 and Q602 without any factory adjustments being required. Also, at any point in the signal, both transistors are always conducting so that crossover distortion is well catered for. R612 (1kΩ) and the illegible 75kΩ resistor above it form an important voltage divider. It sets the DC quiescent output volts to about half of the 103V supply in the following manner.

At power on, both emitter junctions of Q601 and Q602 are in series, DC wise, (pretend the diode D601 does not exist – open circuit) but Q602's base-emitter junction is highly desensitised by having resistor R612 across it. So the sensitive Q601 will attempt to draw heaps of positive potential down to the output rail. However, as soon as about 50V positive has gathered there, the voltage divider 75kΩ/1kΩ has enough voltage at the base of Q602 (0.6V?) to start turning Q602 on. Q602 will then bypass some of the base drive of Q601 to ground and thus stabilise the output volts to about mid supply.

Apart from RF bypass capacitors, C611 and C612, there is no decoupling on the voltage divider, so it also sets the signal stage gain to 76 times or about 37.6dB. C610 must have started to leak about 0.6mA at 50V to have shut Q601 down in the fault.

G. Host,
Doubleview, WA.

More circuit demystification

With regards to the story in the Serviceman's Log in the April 1995 issue, about the AWA C3423 TV sets, my explanation is as follows. Q602, along with R606 & R609, forms a class A amplifier, the output of which feeds emitter follower Q601. This then feeds the junction of R606 & R609 via C610 which forms a bootstrap network, thereby markedly increasing the gain of the class A amp.

DC-wise, Q602 and Q601 form a simple op amp, of which the base of Q602 is the inverting input, the emitter is the non-inverting input and the emitter of Q601 is the output. The circuit is configured as an inverting amplifier with negative feedback provided by R611 & R612, providing a gain calculated by (R611+R612)/R612, which is this case is 76.

With the non-inverting input grounded, the output should be 0V, but unlike a true op amp which would have a negligible input offset voltage, in this case the input offset is set by the base-emitter voltage of Q602. This voltage of around 0.6V effectively appears in series with the non-inverting input and, multiplied by a gain of 76, would produce an output voltage of 45.6V. This may vary somewhat, however, depending on the actual base-emitter voltage of Q602 and how much current flows into the base of Q602.

AC-wise, Q602 and Q601 form a high gain, high voltage buffer, fed from the output of IC101 pin 3, via C609. In this way, the output swing of IC101 is kept very small, allowing it to operate within its power supply rails. Although not stated, I have assumed them to be +12V and ground. The overall gain is then set by the formula (R610+R604)/R604. From the diagram, I have assumed that the SIF amp of IC101 would be some form of op amp but due to the inversion through Q602, the feedback would need to be applied to the non-inverting input of the SIF op amp (pin 2 of IC101).

As for D601, which you suggested causes Q601 to be reverse biased, I am not certain of its purpose but would assume it forms some sort of protection for Q601, possibly in the event that the circuit is driven into clipping.

Looking at the fault, you mentioned that Q601 had failed but did not say in what respect. If it had gone short circuit between collector and emitter, then the negative side of C610 would be held at the positive rail. With Q602 still working, the positive side of C610 would almost always be less than the rail voltage, thus causing it to be reversed biased through Q602 and R609. As R609 is 36kΩ, it is unlikely that C610 would be completely damaged but may have become unreliable. When heated, it might have gradually become leaky, causing the base-emitter junction of Q601 to be joined via R609, thus allowing the DC voltage across this junction to drop to the 0.05V that you measured, causing gross distortion.

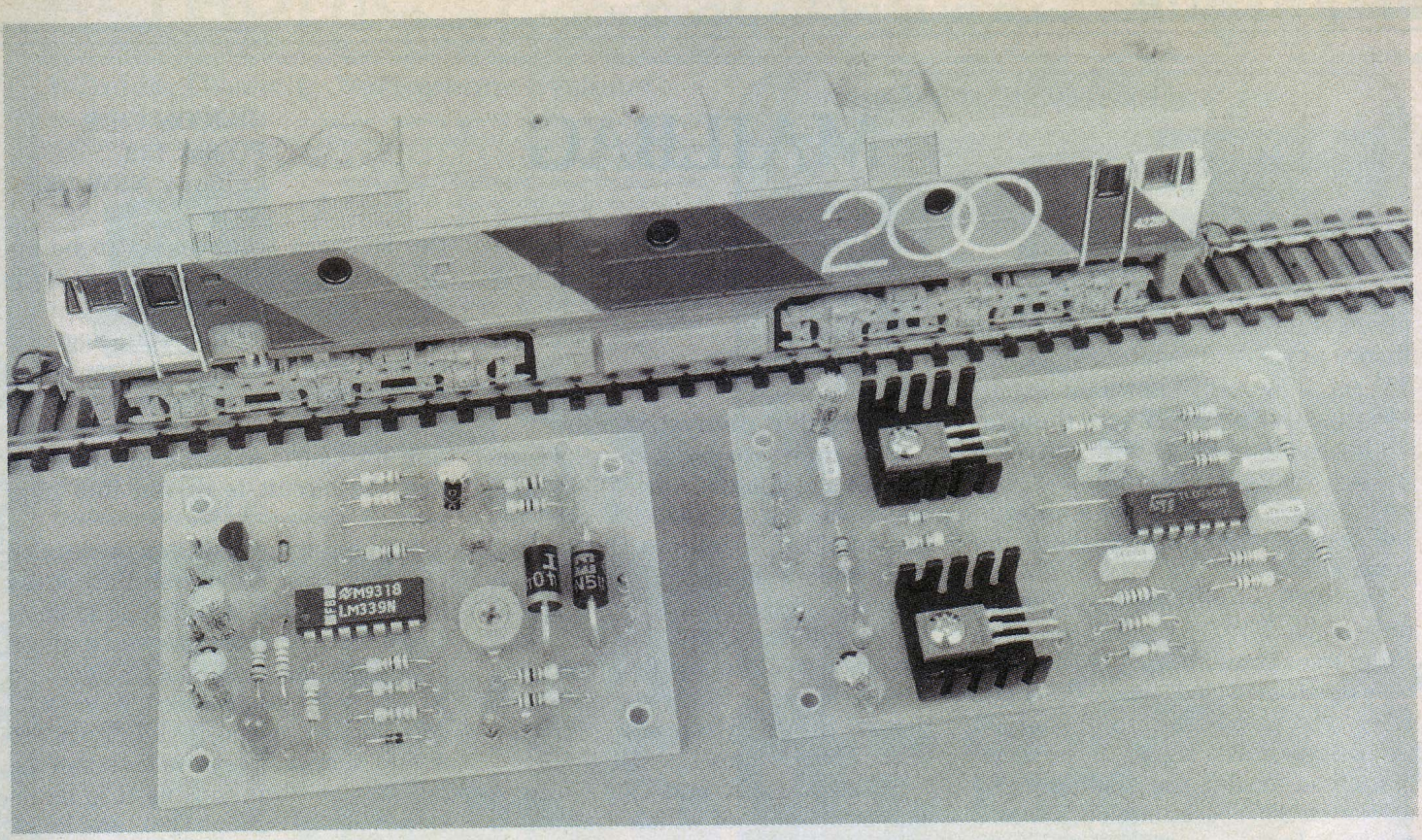
You should note that the negative side of C605 is joined, via R610, to the emitter of Q601, which is biased to half the rail voltage. R604 joins the positive side of C605 to ground, thus causing it to be reverse biased. If this is the case in reality, then C605 will tend to have a shortened life span.

S. Ward,
Dundas, NSW.

Kenwood amplifier circuit

I need help with a Kenwood KA 2002A amplifier of around 1971 vintage. I need a circuit diagram or a service manual for the unit and also wish to know where I could obtain a 50kΩ dual logarithmic pot with tappings at 50%? No-one seems to be able to help at all so far, including the manufacturer, so if anyone has these items or can tell me where to find them please help.

Brett McPhee, PO Box 518,
Moss Vale, NSW 2577.



A train detector for model railways

If you want automatic signalling on a model railway, the first requirement is reliable train detection in each track section or "block". This circuit provides detection of trains whether or not track voltage is present. It is based on a cheap & readily available quad comparator IC, the LM339.

By JOHN CLARKE

Sooner or later, most railway modellers want more realistic operation. They might have built one of our very popular train controllers but then they will want realistic signalling and points switching. As a first step towards this goal, you need to be able to detect the presence of a train or loco in a particular track section or "block".

By way of explanation, it is normal practice to divide the railway layout into sections which can normally be isolated by points switching. Most modellers do this as a step towards having more than one train on the layout, controlled by several train controllers.

As things become more complicated and as the need for automatic switching arises, you need reliable train detection. If this is not done, the signalling system won't make much sense because you won't know if sections of track are clear or not. So one train detector is required for each block.

The requirements for a reliable train detector are actually quite stringent. It should be able to detect the presence of a locomotive or even a single wagon or carriage, whether or not voltage from the controller is present on the track. So even if the track section is dead, you need to know if a loco is there or not.

Also required is a sensitivity adjustment and a built-in time delay to prevent false triggering. The circuit must also work for positive or negative track voltages and function reliably whether the train controller output is smooth DC, unfiltered DC or pulsed DC.

In order to meet all these require-

Fig.1: the circuit of the block detector uses an LM339 quad comparator IC to sense the track current drawn by a locomotive. If the train controller is not present, or set for zero output, an AC signal at 50Hz or 25kHz provides a detectable current.

ments, we have designed three PC boards. The first is the basic block detector; the second, a power supply for up to 30 detectors; and the third an optional high frequency AC power supply to enable the detector to work with pure DC train controllers. Since most modellers use controllers which are pulsed or unfiltered DC, they will not need the optional high frequency driver.

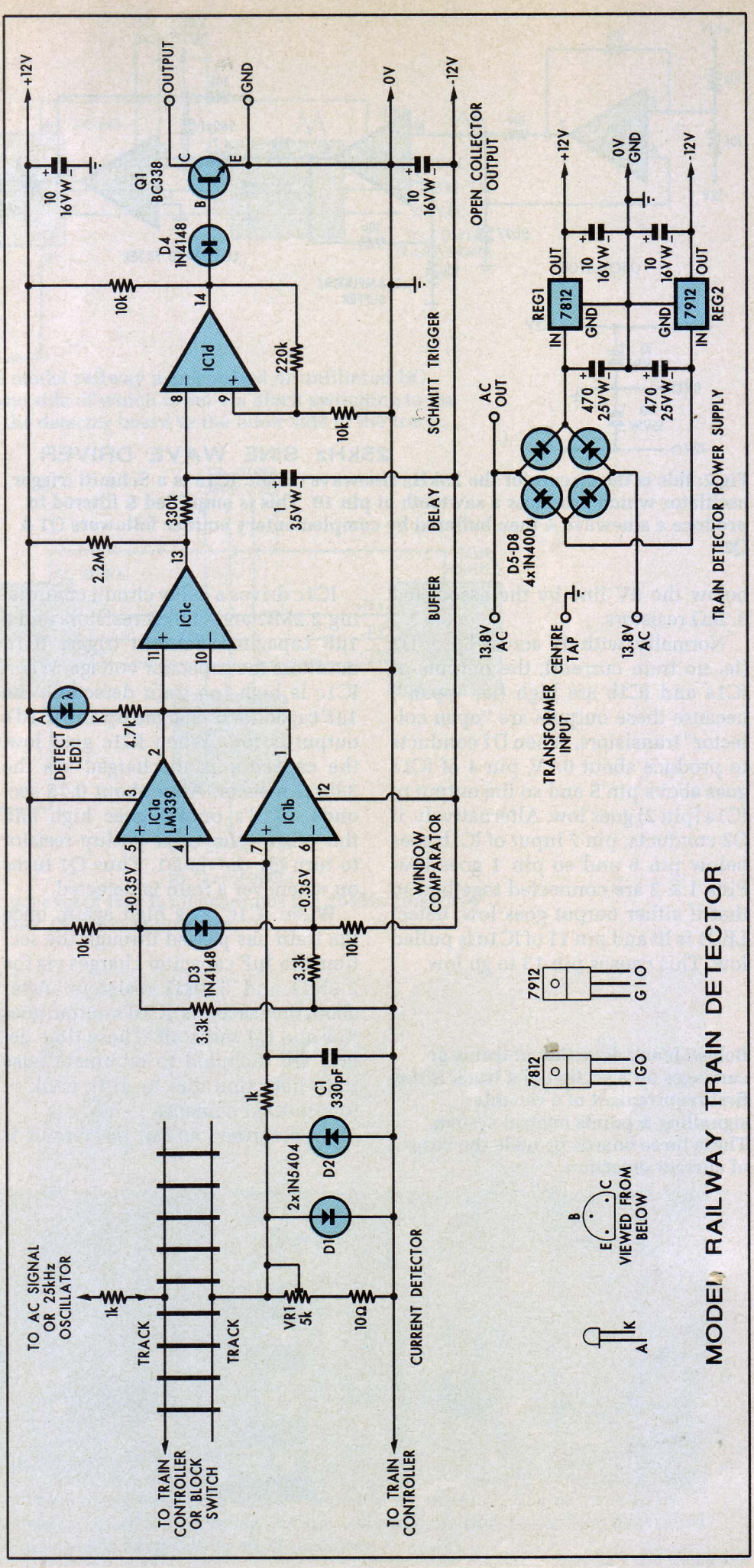
Block detector

Fig.1 shows the circuit for the basic block detector. It uses an LM339 quad comparator IC, four diodes, a few resistors, capacitors and a LED. The output is an open collector transistor which is turned on whenever a train is detected.

The detector circuit connects to both sides of the track and to one side of the train controller output. In effect, the locomotive (or train) current flows through the detector circuit, specifically through trimpot VR1 and diodes D1 or D2, depending on the track polarity. As a result, the voltage developed across D1 or D2 is then detected by the following circuit.

Trimpot VR1 is the sensitivity control. It is connected in parallel with the reverse connected diodes D1 & D2, via a 10Ω resistor. Hence, for very low currents drawn by the train, the voltage to be detected will be developed across trimpot VR1 and its series 10Ω resistor. Higher currents will pass through one of the diodes and thus the voltage detected will be limited to ±0.7V. The diodes are rated at 3A, which sets the limit on the maximum train current.

The voltage developed across the diodes is connected to pins 4 & 7 of IC1a and IC1b. Together, these form a "window" comparator with the window voltage set to ±0.35V by diode D3, connected between pins 5 & 6. D3 is biased by 10kΩ resistors connected to the ±12V supplies and its anode and cathode are tied to sit above and



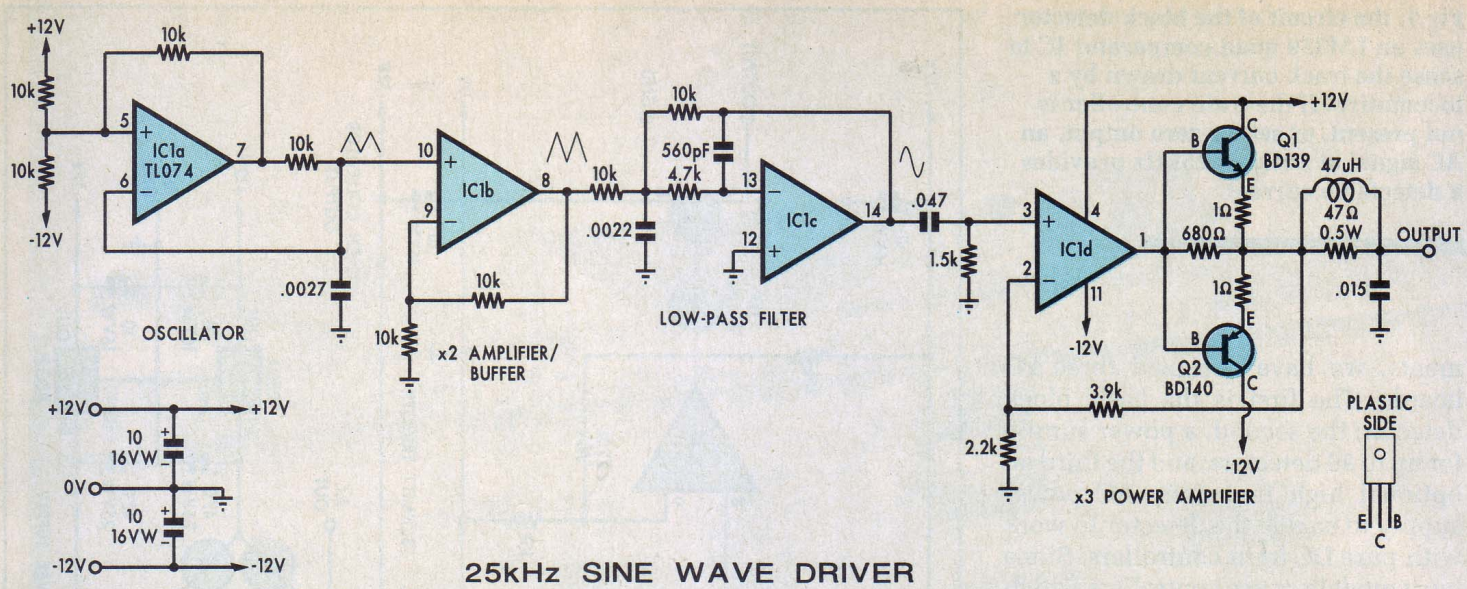


Fig.2: this is the circuit for the 25kHz sinewave driver. IC1a is a Schmitt trigger oscillator which produces a sawtooth at pin 10. This is amplified & filtered to produce a sinewave & then buffered by complementary emitter followers Q1 & Q2.

below the 0V line by the associated 3.3kΩ resistors.

Normally, with 0V across D1 or D2 (ie, no train current), the outputs of IC1a and IC1b are high (ie, "open") because these outputs are "open collector" transistors. When D1 conducts to produce about 0.7V, pin 4 of IC1a goes above pin 5 and so the output of IC1a (pin 2) goes low. Alternatively, if D2 conducts, pin 7 input of IC1b goes below pin 6 and so pin 1 goes low. Pins 1 & 2 are connected together, so that if either output goes low, detect LED1 is lit and pin 11 of IC1c is pulled low. This causes pin 13 to go low.

Below: block detection of trains or carriages on a section of a track is the first requirement of a reliable signalling & points control system. These three boards provide the basis of current detection.

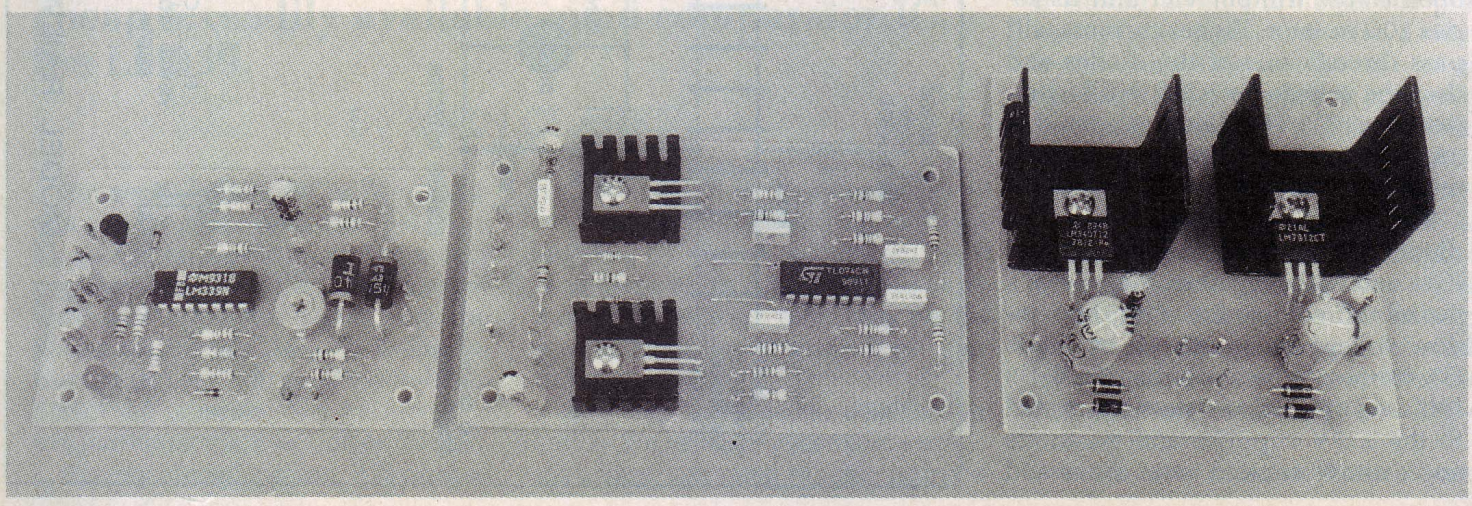
IC1c drives a delay circuit comprising 2.2MΩ and 330kΩ resistors and a 1µF capacitor. Schmitt trigger IC1d monitors the capacitor voltage. When IC1c is high (no train detected), the 1µF capacitor is charged up and IC1d's output is low. When IC1c goes low, the capacitor is discharged via the 330kΩ resistor. After about 0.75 seconds, IC1d's output goes high and this allows the 10kΩ pullup resistor to turn Q1 on via D1. Thus Q1 turns on whenever a train is detected.

When IC1c goes high again, once the train has passed through the section, the 1µF capacitor charges via the 2.2MΩ and 330kΩ resistors. After about thee seconds, IC1d's output goes low and Q1 turns off. These time delays are included to eliminate false train detection due to dirty track or intermittent contacts.

As described so far, the circuit is based on a design featured in the March 1982 issue of "Model Railroader". But as presented so far, the circuit will not detect the presence of a locomotive unless track voltage is applied. The original circuit attempted to solve this problem by providing a DC bias to the track such that, while it was insufficient to operate a locomotive, or even train lighting, it would create a small current which could be detected. The drawback to this scheme is that a small throttle setting on the train controller could cancel the bias voltage and then you would have a situation where trains could not be detected.

AC bias

The way around this problem is to provide a 50Hz AC bias and this is shown fed to the track via a 1kΩ resistor. Now, regardless of the setting of the train controller or whether it is connected or not, the AC bias will always produce a current that can be detected by the window comparator.



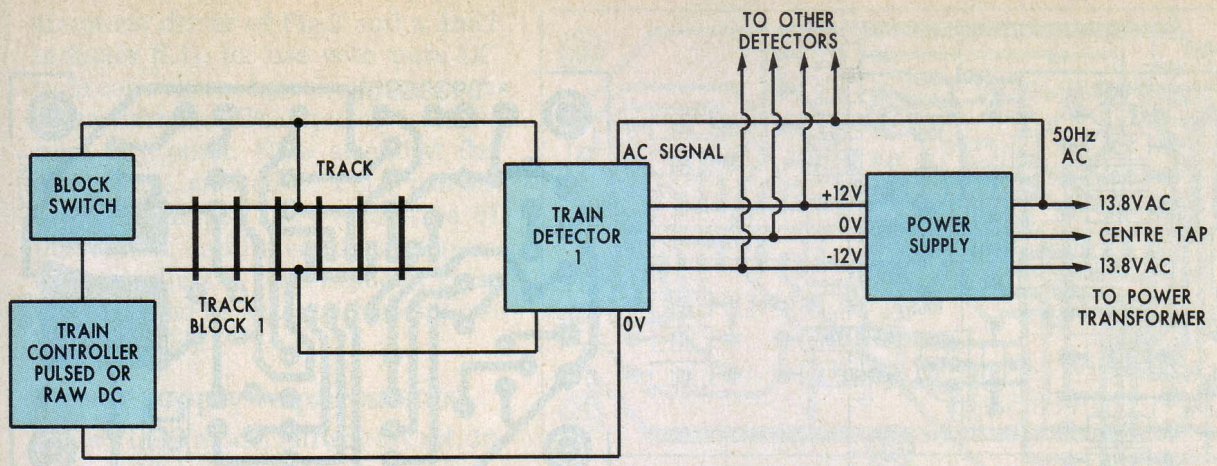


Fig.3: the connection arrangement for a typical model railway using pulsed or unfiltered DC controllers. At left, there is a train controller, one side of which is fed via block switching to the track. The other side of the controller goes via the detector board to the other side of the track.

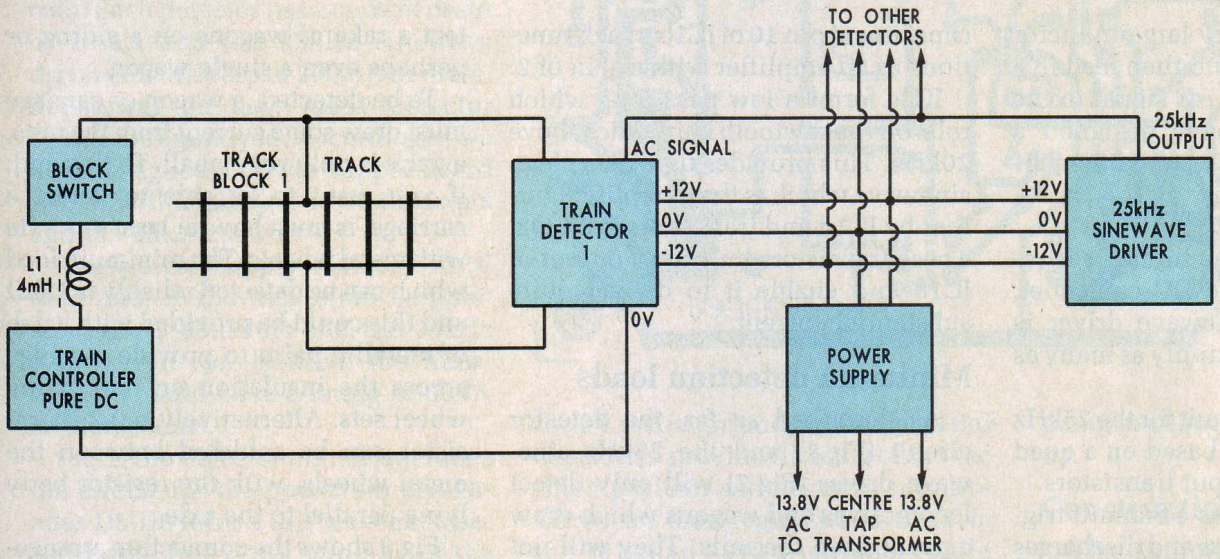
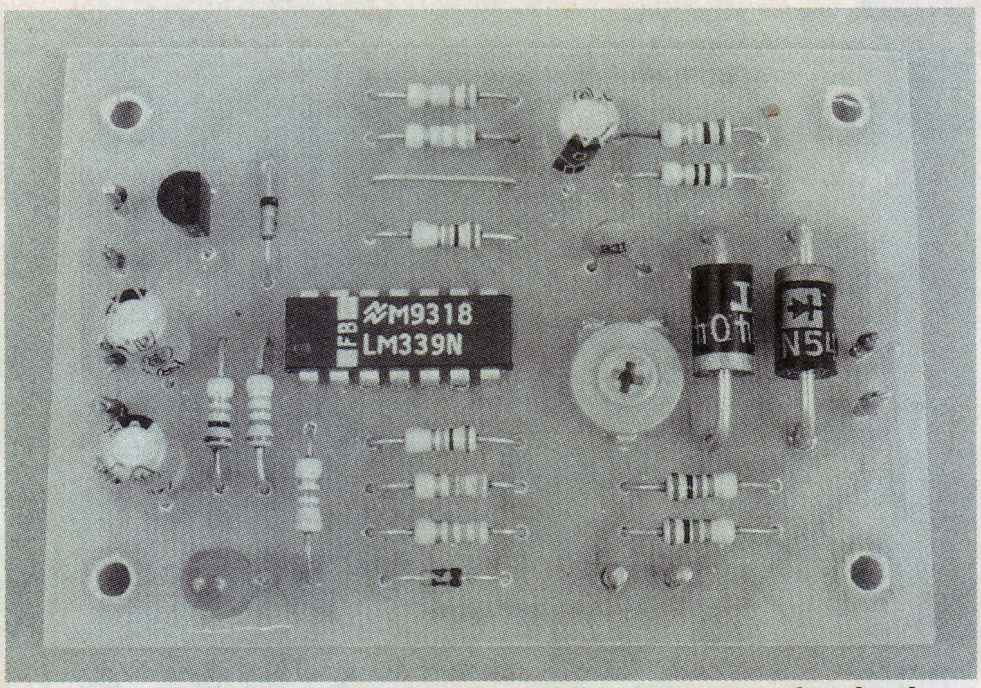


Fig.4: this arrangement is almost identical to Fig.3 except that it incorporates the 25kHz sinewave driver of Fig.2 & a 4mH inductor, for use with pure DC train controllers.

There are still a few wrinkles to take care of, though.

First, we have to cater for the situation where a train controller is connected to the track but is set to produce zero voltage. This can present a real problem with train controllers which produce a pure DC output. Why? Because they present a very low impedance across the track, no matter what their voltage setting. Usually, they also have a large electrolytic capacitor across their output and this compounds the problem – it effectively shorts out the AC bias and so once again, we have a situation where a train cannot be detected.

The solution with pure DC controllers is to connect an inductor in series with their output so that the impedance is high at high frequencies but virtually zero at DC. The trouble is that if 50Hz AC is used, the inductor has to be very large to be effective. So



One of these block detector boards is required for every section of track to be monitored. A small layout might require only five or six detector boards while a large layout might require up to 30 or more.

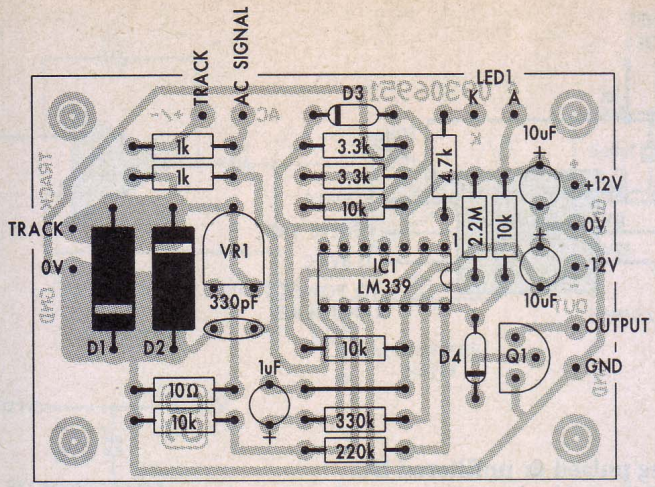


Fig:5(a): follow this component overlay diagram when building the detector PC board.

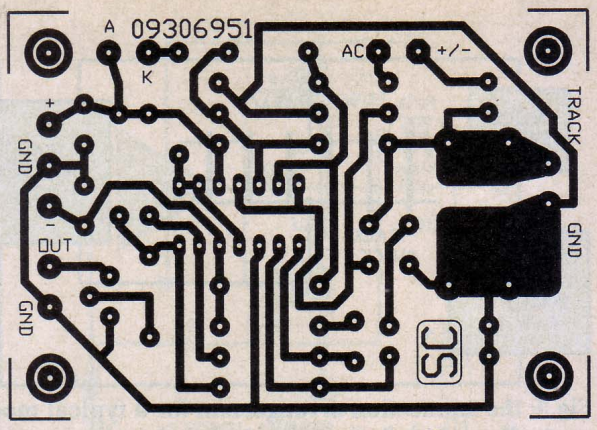


Fig.5(b): actual size artwork for the detector PC board.

rather than use a very large inductor we use a small one and then feed in a very high frequency AC signal to the track. Hence, we have designed a 25kHz sinewave driver to do the job.

25kHz sinewave driver

Note that while one inductor is required for each pure DC controller, only one 25kHz sinewave driver is needed since it can supply as many as 20 train detectors.

Fig.2 shows the circuit for the 25kHz sinewave driver. It's based on a quad op amp and two output transistors.

IC1a is connected as a Schmitt trigger oscillator. It charges and discharges the .0027µF capacitor via a 10kΩ resistor. The result of this is a 25kHz sawtooth waveform across the .0027µF capacitor at pin 10 of IC1b which functions as an amplifier with a gain of 2.

IC1c forms a low pass filter which rolls off the sawtooth harmonics above 20kHz. This provides us with a clean sinewave which is then amplified further by IC1d and transistors Q1 & Q2. These transistors buffer the output of IC1d and enable it to deliver quite substantial current.

Minimum detection loads

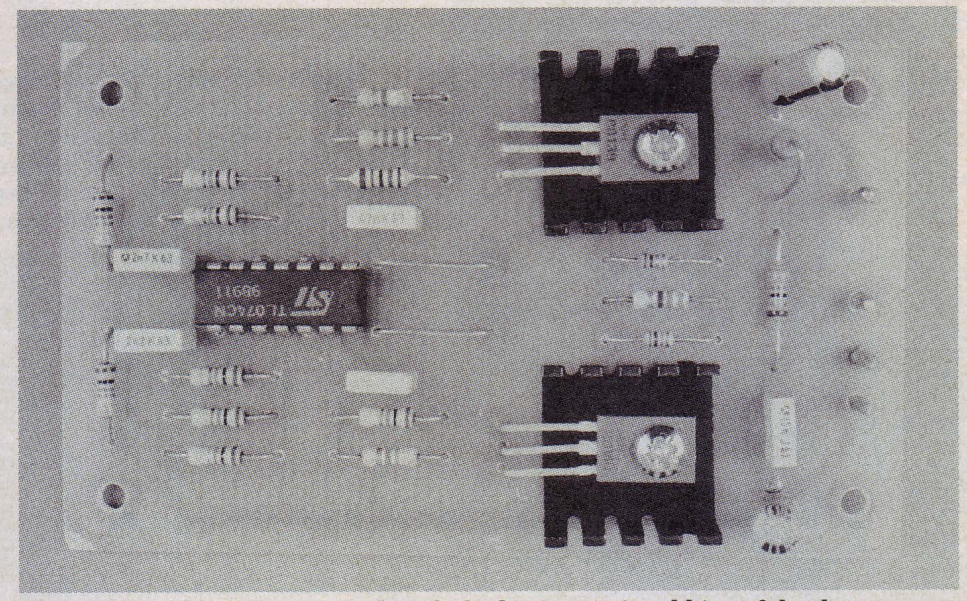
As described so far, the detector circuit (Fig.1) and the 25kHz sinewave driver (Fig.2) will only detect locomotives and wagons which draw current from the rails. They will not detect wagons or carriages which do not draw current. This is undesirable since you will want to be able to detect a rake of wagons on a siding or perhaps even a single wagon.

To be detected, a wagon or carriage must draw some current from the rails, even it is only very small. To this end, if you want to be able to detect a carriage, is must have at least one axle with metal wheels. The minimum load which can be detected reliably is 12kΩ and this could be provided with a dab of metallic paint to provide a bridge across the insulation on one of the wheel sets. Alternatively, a 0.25W resistor can be soldered between the metal wheels, with the resistor body lying parallel to the axle.

Fig.3 shows the connection arrangement for a typical model railway using pulsed or unfiltered DC controllers. At left, there is a train controller, one side of which is fed via block switching to the track. The other side of the controller goes via the detector board to the other side of the track. Note that one side of the train controller is connected to the 0V line of the detector board. **This means that each controller on a layout must be completely independent of any other controller and two or more controllers cannot be run from a common power supply.**

Note that Fig.3 (and Fig.4) shows the detector board run from a power supply which is connected to a transformer with a centre-tapped 27.6V secondary (ie, 13.8V-0-13.8V). While this is what we did with our prototype, in practice any transformer with a centre-tapped winding of between 24V (ie, 12V-0-12V) and 30V (15V-0-15V) will do.

Fig.4 is almost identical to Fig.3 except that it incorporates the 25kHz



If pure DC controllers are employed, the basic AC signal bias of the detector board will not work. The solution is to use an isolation inductor in series with each controller & use this 25kHz sinewave driver board. Only one of these boards is required for a complete layout.

sinewave driver of Fig.2 and a 4mH inductor (L1), for use with pure DC train controllers. Again, note that each controller must be completely isolated from any other. Note also that the connection method of Fig.4 can be employed if you have a mixture of pulsed DC, unfiltered DC and pure DC controllers. A 4mH inductor must be connected in series with each pure DC controller.

Power supply requirements

For a large model railway layout, 20 or even 30 detectors may be required. Add to that the possible need for a 25kHz sinewave driver (Fig.2) and the power requirements become significant. Each detector has a current drain of 20mA and the 25kHz sinewave driver can draw up to 200mA or more, depending on how many detector boards are employed. Accordingly, we have designed a power supply board which will handle up to 30 detectors and the 25kHz driver.

The power supply delivers ±12V rails and, if the maximum complement of 30 detectors and the 25kHz sinewave driver is used, the transformer should have a rating of 60VA or thereabouts.

Fig.1, the detector circuit, includes the circuit for the power supply. Diodes D5-D8 form a full-wave rectifier across the full 27.6V winding of the transformer. The centre tap becomes the 0V rail or ground, while the 470µF capacitors provide filtering of the rectified positive and negative supplies. These are then regulated to ±12V by the 7812 and 7912 3-terminal regulators. The 10µF capacitors at the output of each regulator prevent instability.

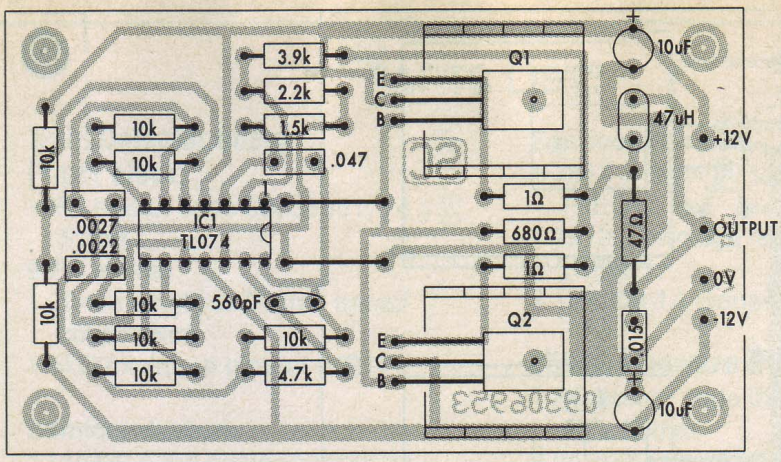


Fig.6(a): the parts layout diagram for the 25kHz sinewave driver board.

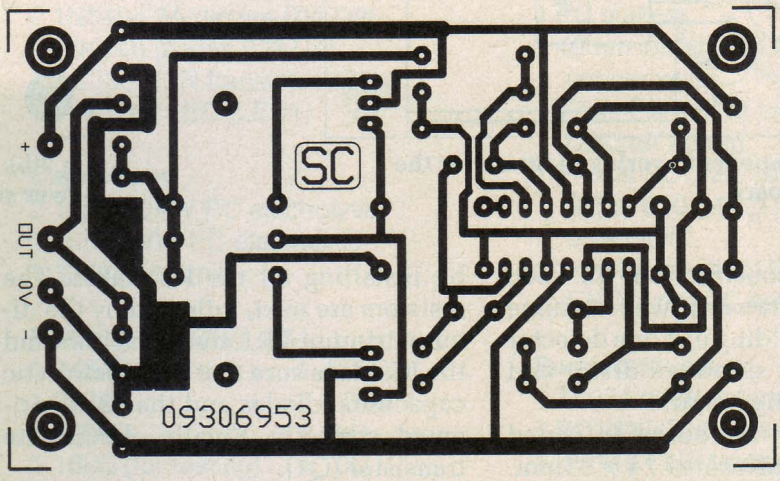
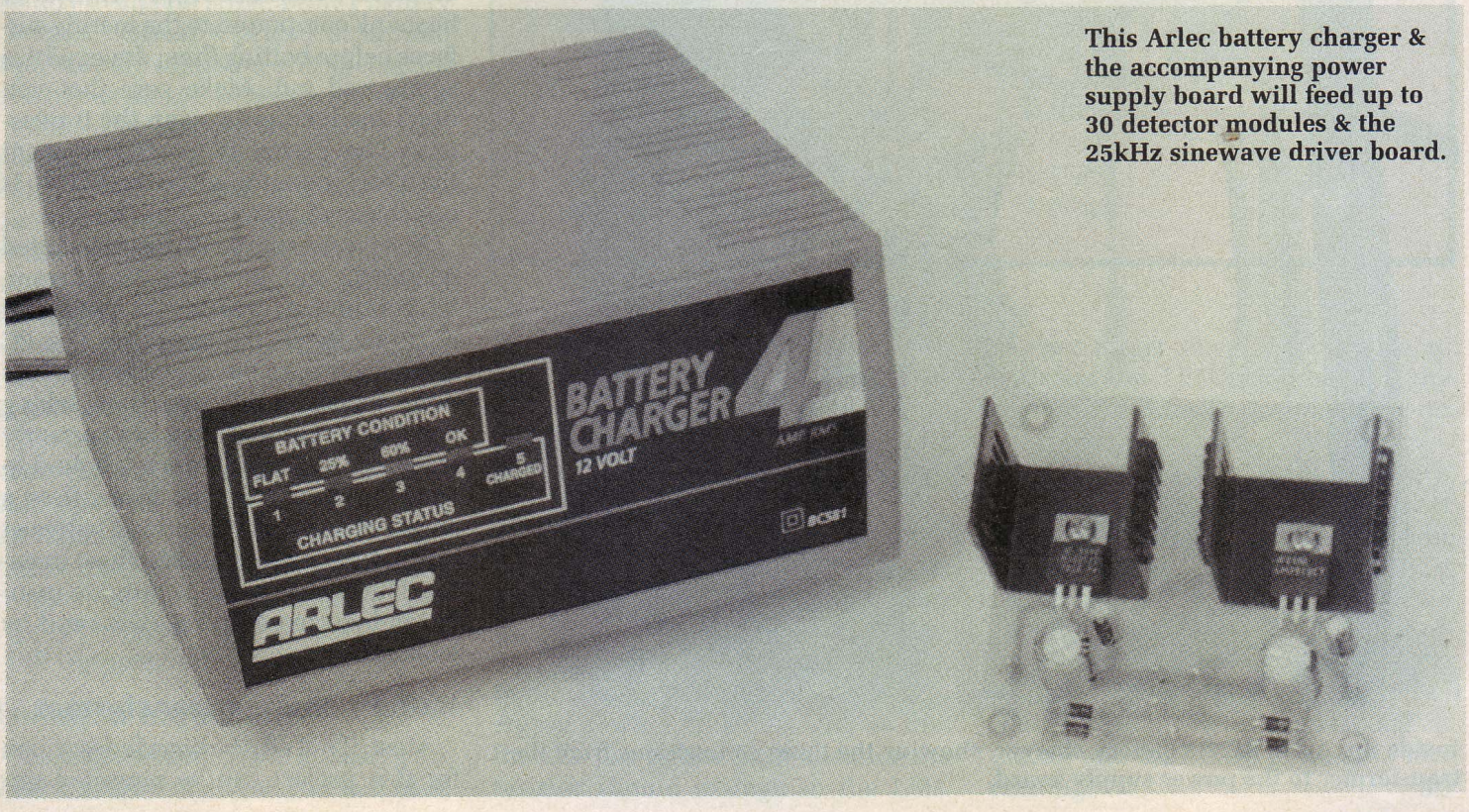


Fig.6(b): the actual size artwork for the 25kHz driver PC board.

Construction

That completes the circuit description of the three modules. Now let us



This Arlec battery charger & the accompanying power supply board will feed up to 30 detector modules & the 25kHz sinewave driver board.

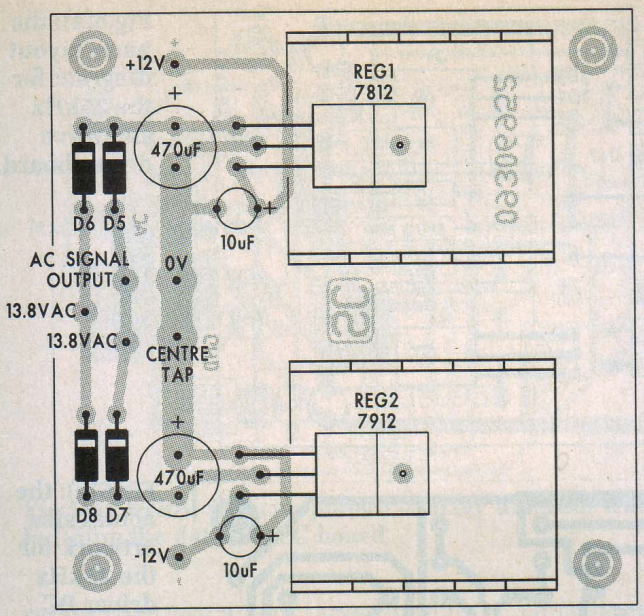


Fig.7(a): the component overlay diagram for the power supply board.

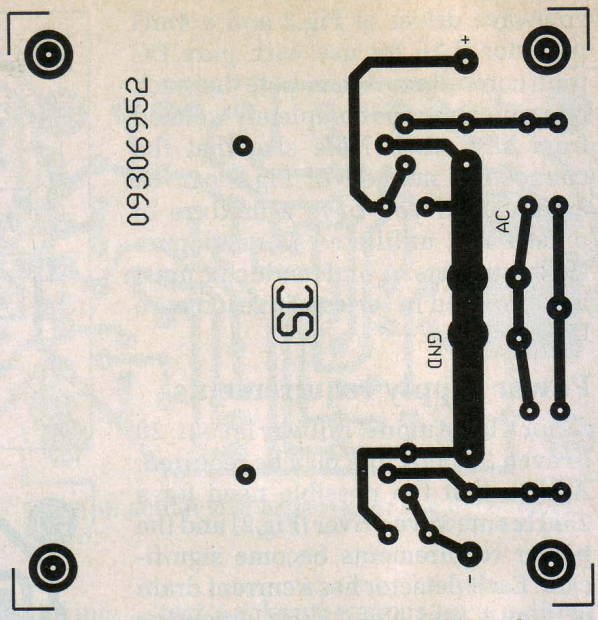


Fig.7(b): this is the actual size artwork for the power supply board.

look at their construction. To keep things straightforward, we'll assume that you are building just one detector board, a 25kHz sinewave driver and the power supply board.

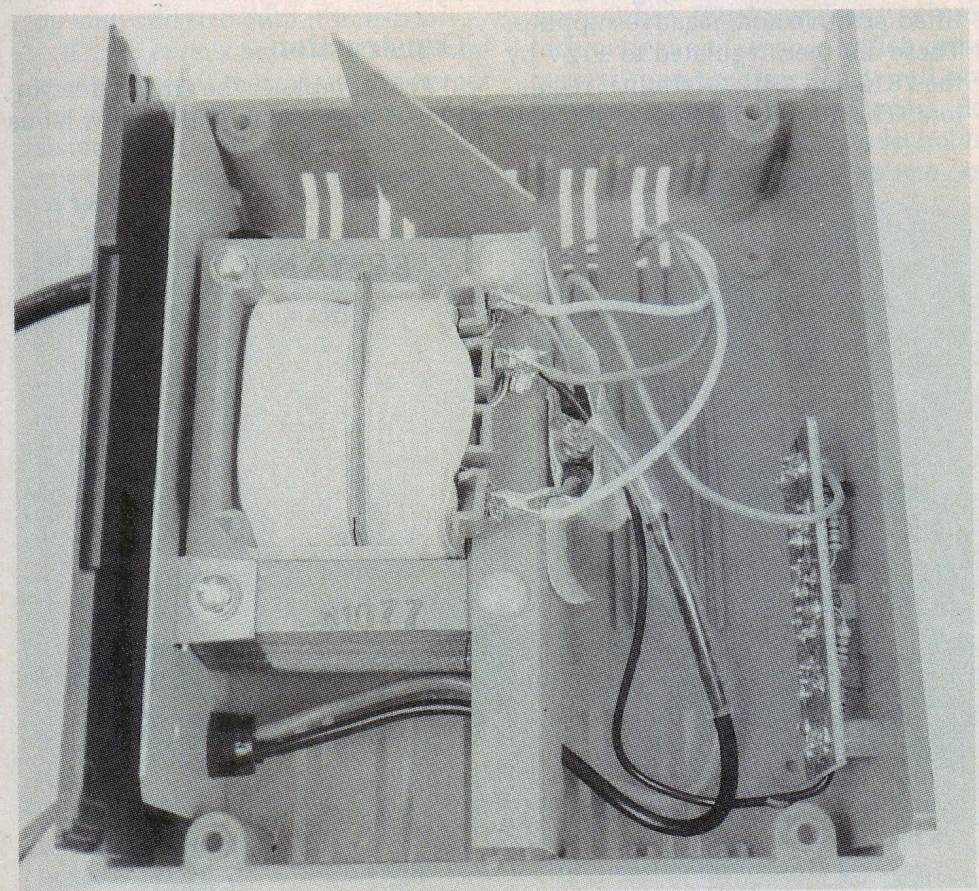
The detector PC board is coded 09306951 and measures 74 x 51mm. Its component overlay diagram is shown in Fig.5(a). Begin construction by installing all the PC stakes. The resistors are next, followed by the diodes, trimpot VR1, the capacitors and the IC. Make sure that the electrolytic capacitors, diodes and the IC are oriented correctly. Finally, mount the transistor (Q1).

The 25kHz sinewave PC board is coded 09306953 and measures 93 x 56mm. Its parts layout is shown in Fig.6(a). Again, begin by installing the PC stakes and then the two links. Next, install the IC taking care with its orientation. The same comment applies to the polarity of the electrolytic capacitors.

Install the resistors next (check their values on a digital multimeter). The 47µH inductor may be a PC mounting type or an axial type which looks similar to a resistor. The latter type can be mounted end on in the PC board.

Transistors Q1 and Q2 are mounted on small heatsinks. Apply a smear of heatsink compound to the mating surfaces before bolting them down with a screw and nut. Make sure that you don't inadvertently swap the transistors. The BD139 is located adjacent the 47µH inductor while the BD140 is opposite the .015µF capacitor.

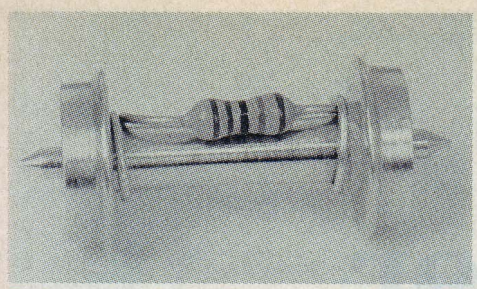
The power supply PC board is coded 09306952 and measures 73 x 73mm. Its component overlay is shown in Fig.7(a). Begin by installing the PC stakes and then the four diodes. This done, solder in the capacitors, taking care to ensure that they are correctly oriented. The regulators are bolted to small heatsinks on the board. Use a smear of heatsink compound between the mating surfaces to aid in heat transfer. There is no need to provide insulation between each regulator and its heatsink.



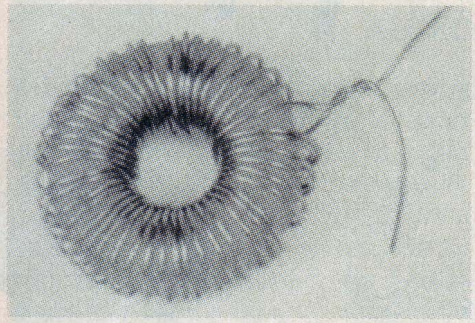
Inside the Arlec BC581 battery charger, showing the three connections from the transformer to the power supply board.

Battery charger transformer

Most, if not all, the boards described for this project can be mounted un-



This photo shows how a 12kΩ 0.25W resistor is soldered to the flanges of a metal wheelset. This will provide the minimum detectable load so that a carriage or wagon can be sensed on the track.



If you are using the 25kHz sinewave driver, you will need an isolation inductor in series with each pure DC controller. This consists of 45 turns of 0.5mm enamelled copper wire on a Philips RCC/20/10/7 3C85 toroid.

PARTS LIST

Train Detector Board (1 per block)

1 PC board, code 09306951, 74 x 51mm
9 PC stakes
1 20mm length of 0.8mm tinned copper wire
1 5kΩ miniature trimpot (VR1)

Semiconductors
1 LM339 quad comparator (IC1)
2 1N5404 3A diodes (D1,D2)
2 1N4148 diodes (D3,D4)
1 BC338 NPN transistor (Q1)
1 5mm red LED (LED1)

Capacitors
2 10µF 16VW PC electrolytic
1 1µF 35VW PC electrolytic
1 330pF ceramic

Resistors (0.25W, 1%)

1 2.2MΩ	1 4.7kΩ
1 330kΩ	2 3.3kΩ
1 220kΩ	2 1kΩ
1 15kΩ (for testing)	1 10Ω
4 10kΩ	

Power Supply Board

1 27.6V centre tapped 60VA transformer (Arlec BC581 battery charger; see text)
1 PC board, code 09306952, 73 x 73mm
2 mini-U heatsinks, 30 x 25 x 13mm or 25 x 28 x 28mm
7 PC stakes
2 3mm screws and nuts
2 470µF 25VW PC electrolytic capacitors
2 10µF 16VW PC electrolytic

Semiconductors
1 7812 3-terminal regulator (REG1)
1 7912 3-terminal regulator (REG2)
4 1N4004 1A diodes (D1-D4)

25kHz Sinewave Driver Board

1 PC board, code 09306953, 93 x 56mm
2 micro heatsinks, 19 x 18 x 9mm
4 PC stakes
1 40mm length of 0.8mm tinned copper wire
1 47µH PC mount inductor (250mA rating)
1 Philips RCC/20/10/7 3C85 core (4330 030 34471) per DC controller
1 2-metre length of 0.5mm ENCW per DC controller

Semiconductors
1 TL074 quad op amp (IC1)
1 BD139 NPN transistor (Q1)
1 BD140 PNP transistor (Q2)

Capacitors
2 10µF 16VW PC electrolytic
1 0.047µF MKT polyester
1 0.015µF MKT polyester
1 0.0027µF MKT polyester
1 0.0022µF MKT polyester
1 560pF MKT polyester or ceramic

Resistors (0.25W, 1%)

8 10kΩ	1 1.5kΩ
1 4.7kΩ	1 680Ω
1 3.9kΩ	1 47Ω
1 2.2kΩ	2 1Ω

derneath the layout. However, the power transformer must be correctly wired and mounted in a case to make it safe. To this end, we opted to use a readily available Arlec BC581 battery charger. Normally priced at around $40, they are sometimes on special for as little as $29.95 in hardware stores.

The Arlec charger comes in a neat plastic case which is safe and convenient for our purpose. All that is required is to connect three wires, one to the centre tap and one to each of the 13.8V terminals on the secondary of the transformer. The battery leads and remaining components on the charger can be left connected provided the leads are not shorted together.

The accompanying photographs show the transformer connections inside the Arlec battery charger. Once the connections are made from the transformer to the power supply board, reassemble the battery charger case. Apply power and check the +12V and -12V outputs on the board.

Isolation inductor

As noted above, if you are using the 25kHz sinewave driver, you will need an isolation inductor in series with each pure DC controller. This inductor consists of 45 turns of 0.5mm enamelled copper wire on a Philips RCC/20/10/7 3C85 toroid – see photo.

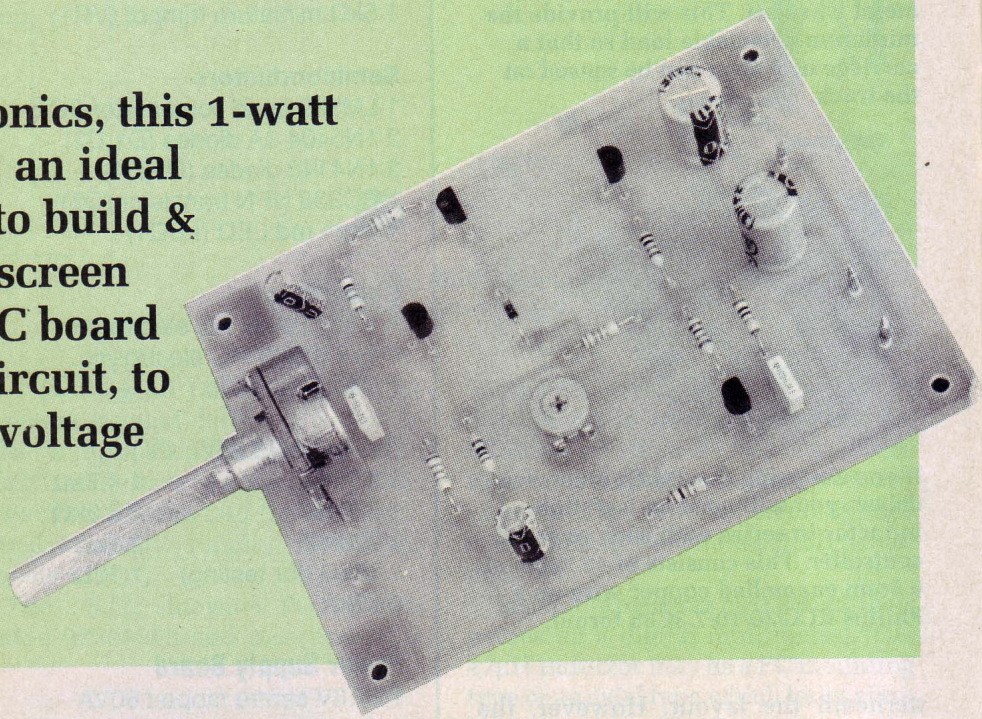
Testing

Connect the +12V, 0V, -12V and AC outputs from the power supply board to the detector PC board. Now connect a 15kΩ resistor between the track terminals on the detector PC board. Apply power and adjust VR1 so that the LED just lights. Disconnecting the resistor should extinguish the LED. Do not forget that there is a delay between the LED response and the output. Final testing can be done on the layout.

Now check the 25kHz sinewave driver. Apply power and check that the transistors run cool. You can test the sinewave output by connecting a multimeter set on the AC range to the output. You should obtain a reading of around 8V. This will depend on your multimeter's frequency response, though – some will not respond at 25kHz and will only produce a low reading. **SC**

A 1-watt audio amplifier trainer

If you're new to electronics, this 1-watt audio amplifier makes an ideal introduction. It's easy to build & the component layout screen printed on top of the PC board is very similar to the circuit, to make signal tracing & voltage measurements easy.



By JOHN CLARKE

Audio amplifiers come in many shapes and sizes. They range from low-cost units with just enough power to drive a pair of headphones (eg, for a personal portable) right up to large units capable of driving the huge speaker blocks used at rock concerts. They are used in all sorts of equipment, including TV sets, CD players, stereo amplifiers, radio receivers and computer sound cards.

Although building large amplifiers can be complicated, that certainly doesn't apply to the low-power unit described here. This 1W Audio Amplifier Trainer is easy to assemble and uses only common, low-cost parts. If you accidentally damage any of these parts during construction, they can generally be replaced for less than 50 cents.

To make it as easy for the beginner as possible, the PC board has a screen printed overlay (not included on our prototype) which shows the positions of all the parts. This layout closely follows the circuit diagram layout, so that you can more easily understand how it works.

To build the unit, all you have to do is follow the screen printed overlay. Provided your soldering is up to scratch, your amplifier should work as soon as it is switched on.

Performance With 12V Supply

Output power into 8-ohm	1.1W at onset of visible clipping
Sensitivity	150mV for 1W output into 8-ohm
Signal to noise ratio	74dB unweighted with respect to 1W, 20Hz to 20kHz bandwidth & 1kΩ input load; 101dB A-weighted
Distortion	<1.2% at 1kHz at 1W into 8-ohm
Frequency response	-3dB at 60Hz & 90kHz (8-ohm load)

Output stage basics

Fig.1 shows the complete circuit of our 1W Audio Amplifier Trainer. It employs what is known as a class AB "push-pull" or "complementary" output stage. These two terms have similar meanings and refer to the way in which the output transistors (Q3 & Q4) are connected.

As shown in Fig.1, Q3 is an NPN transistor and Q4 is a PNP type (ie, they are complementary types). These two transistors have their emitters connected together via 1Ω resistors, while their collectors go to the supply rails (+9V in the case of Q3, ground or 0V in the case of Q4).

In operation, Q3 conducts (ie, current flows from collector to emitter) when its base voltage is 0.6V higher than its emitter. Conversely, Q4 conducts when its base voltage is 0.6V lower than its emitter.

To better understand this, take a look at Fig.2. This shows a simplified complementary output stage being

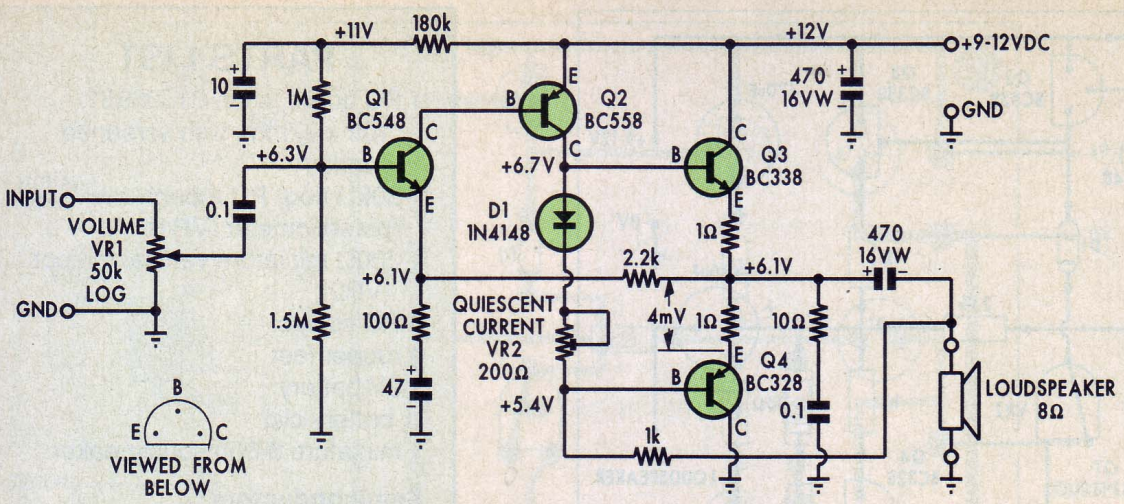


Fig.1: this 4-transistor circuit uses Q3 & Q4 as complementary emitter followers (having close to unity gain) and Q1 & Q2 as the voltage gain stages. Because the output of the amplifier is at half the supply, a DC blocking capacitor is required to couple the amplifier to the loudspeaker.

1W AUDIO AMPLIFIER TRAINER

driven by a sinewave signal. During the positive (top) half-cycle of the input waveform, the top transistor conducts and the bottom transistor remains off. Then, during the negative half-cycle of the input signal, the top transistor turns off and the bottom transistor conducts.

The amplified signal appears at the commoned emitters of the two transistors.

Crossover distortion

If you look closely at the output waveform shown in Fig.2, you can see that it doesn't look the same as the input – there's a small "step" in the waveform each time it crosses the 0V line. We call this effect "crossover distortion". It occurs because the input signal must rise to +0.6V before the top transistor begins to conduct and must drop to -0.6V before the bottom transistor begins to conduct.

For input signal voltages between ±0.6V, both transistors are off and so there is effectively no signal output over this range. This means that the amplified output signal is distorted at the crossover points, as the input signal swings from +0.6V to -0.6V.

To reduce this distortion, we have to apply a permanent 0.6V bias to both transistors, so that they are always slightly on, regardless of the input signal. This simply involves separating the bases of the output pair and connecting them instead to network with 1.2V across it (0.6V for each transistor).

What happens now is that the top transistor will immediately conduct as soon as the input signal rises above 0V. Similarly, the bottom transistor will conduct as soon as the input signal drops below 0V. As a result, most of the crossover distortion is eliminated and the sound quality is greatly improved.

This type of output stage biasing is referred to as "class AB". That's because it operates mainly as a class B output stage, where each transistor is completely off for half the input cycle, but is also biased slightly towards the class A condition, in which the output devices are always biased on.

Clipping

Crossover distortion is not the only form of distortion that can occur in audio amplifier stages. Another major source of distortion is known as "clipping". This occurs when an amplifier is driven into overload.

If you go back to Fig.2, you can see that while there is crossover distortion, the peaks of the output waveform still follow the input signal. This means that the transistors can handle the input signal without overloading. But what happens if the input signal becomes too large to handle?

In a perfect amplifier, the output signal could swing as far as the positive and negative supply rails. In practice, however, the maximum output voltage swing is somewhat less than

Facing page: the prototype of our 1W Audio Amplifier Trainer. Kits will be supplied with a screen printed overlay on the PC board.

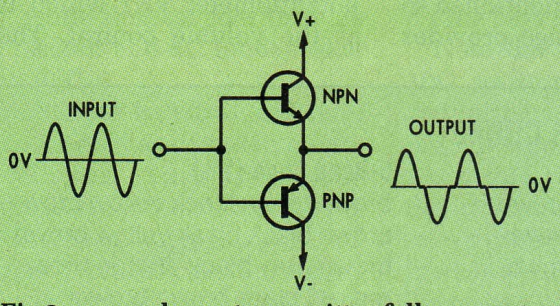


Fig.2: a complementary emitter follower output stage operating in class-B (ie, no bias) will produce crossover distortion in the waveform. A small bias on the output transistors will eliminate most of this distortion.

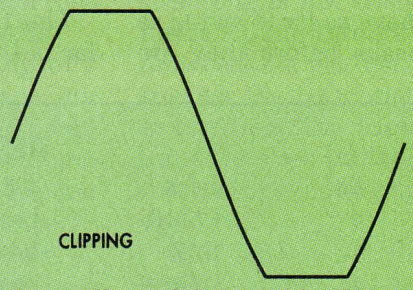


Fig.3: all amplifiers can be driven into clipping if the input signal is too large. An amplifier should be biased so that clipping is symmetrical (ie, the same degree of clipping at top and bottom) so that power output before the onset of clipping is maximised.

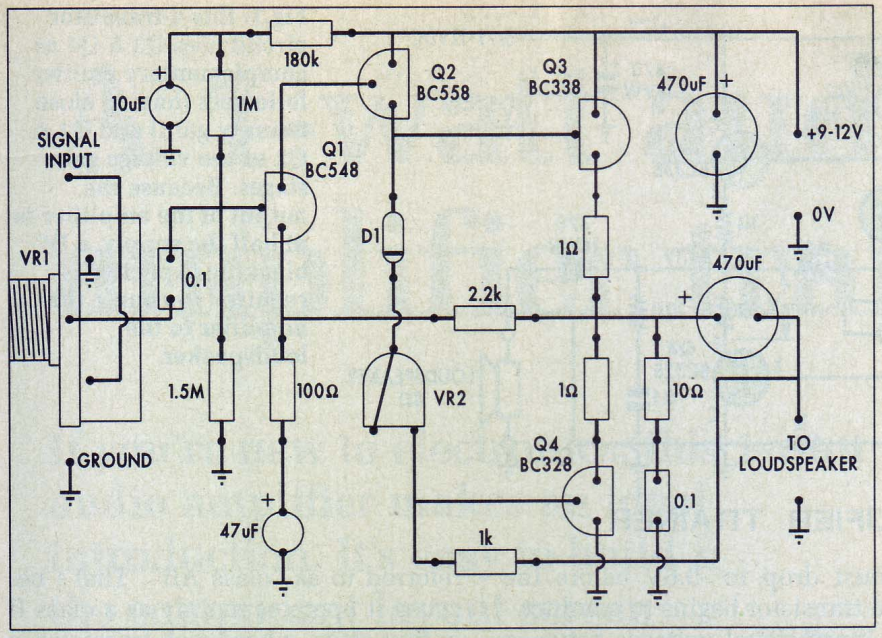


Fig.4: the screen print overlay for the 1W Audio Amplifier Trainer PC board. Compare this layout with the circuit of Fig.2.

this, due to the voltage losses across the output devices and their emitter resistors.

Because of this, a large input signal can easily overload the output stage. This is called "clipping" and its effect on the output waveform is shown in Fig.3. As can be seen, the positive and negative peaks of the waveform are flattened, resulting in severe distortion of the audio. On normal program material, a small amount of clipping may not be audible but in severe cases, it sounds horrible.

Another thing that emerges from Fig.3 is that the DC output of the amplifier should sit at about half supply under no-signal conditions. That way, the output can swing equally to the positive and negative supply rails when an input signal is applied, thus reducing the chances of clipping.

On the other hand, if the DC output is set too high, then the positive signal peaks will not have as far to swing as the negative peaks before they are clipped. The reverse also applies. This gives rise to an effect known as asymmetrical clipping and is highly undesirable since it effectively reduces the available power output.

By the way, Fig.2 shows a transistor output stage with positive and negative supply rails and the output referenced to 0V; ie, halfway between the two supply rails. That is how the more powerful amplifiers are designed but low power amplifiers such as the one discussed here usually have a single supply rail and the DC output is set at close to half this supply voltage. Because of this, a DC blocking capacitor is required between the output transistor emitters and the loudspeaker load. If the capacitor was not included, a heavy DC current would flow through the speaker, even with no signal applied and this could burn out the speaker or damage the amplifier's output transistors.

One thing we haven't mentioned so far is that the output stage provides only current amplification. However, an audio amplifier also needs a voltage amplification stage (or stages) to boost the input voltage so that it's enough to drive a loudspeaker. This is the job of transistors Q1 and Q2 in the circuit of Fig.1.

Circuit details

In addition to the transistors, we need only a handful of parts to produce a complete working amplifier. The input signal is initially applied to potentiometer VR1 which functions as the volume control. The output

PARTS LIST

1 PC board, code 01306951, 109 x 77mm, with screened overlay
1 50kΩ (log) PC mount potentiometer (VR1)
1 200Ω miniature vertical trimpot (VR2)
6 PC stakes
4 rubber feet
1 9V battery
1 battery clip
1 miniature 8-ohm loudspeaker

Semiconductors
1 BC548 NPN transistor (Q1)
1 BC558 PNP transistor (Q2)
1 BC338 NPN transistor (Q3)
1 BC328 PNP transistor (Q4)
1 1N4148 signal diode (D1)

Capacitors
2 470µF 16VW PC electrolytic
1 47µF 16VW PC electrolytic
1 10µF 16VW PC electrolytic
1 0.1µF MKT polyester

Resistors (0.25W, 1%)

1 1.5MΩ	1 1kΩ
1 1MΩ	1 100Ω
1 180kΩ	1 10Ω
1 2.2kΩ	2 1Ω

RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1.5MΩ	brown green green brown	brown green black yellow brown
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	180kΩ	brown grey yellow brown	brown grey black orange brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	1	1kΩ	brown black red brown	brown black black brown brown
❑	1	100Ω	brown black brown brown	brown black black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	2	1Ω	brown black gold gold	brown black black silver brown

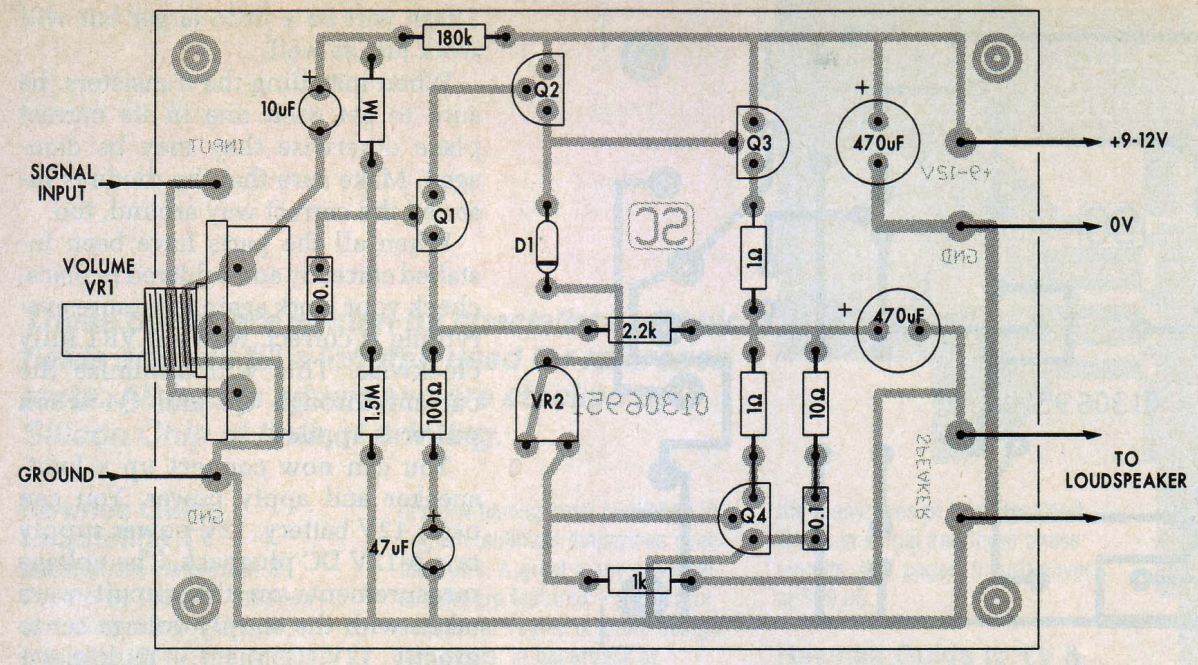


Fig.5: almost identical to Fig.4, this is the component overlay for the PC board. It also shows the copper pattern.

from VR1's wiper is fed to the base of transistor Q1 via the 0.1µF coupling capacitor. This coupling capacitor is necessary because it prevents the DC voltage at the base of Q1 from being varied by different settings of VR1. Because the bias on Q1 determines the DC voltage at the output of the amplifier, we don't want it varied each time you change the setting of the volume control.

Q1 is connected as a common emitter stage and is biased to just over half supply using the 1MΩ and 1.5MΩ resistors at its base. It varies its collector current in response to the audio signal applied to its base and, in turn, drives the base of PNP transistor Q2. Note that because Q2's base is driven by Q1's collector, the audio signal is inverted at this point.

Q2 is also connected as a common emitter stage and provides most of the voltage gain of the amplifier. Its collector current flows partly into the bases of the output transistors (Q3 and Q4), while the rest goes through the 1kΩ resistor and 8Ω loudspeaker to ground (0V).

The two output transistors, Q3 and Q4, are connected as complementary emitter followers. They are slightly biased into forward conduction by the voltage developed across diode D1 and trimpot VR2. This trimpot allows the forward bias voltage applied to the output pair (and thus their quiescent current) to be adjusted to minimise the crossover distortion.

Diode D1 is included to provide a measure of temperature compensation for the bias network. As the ambient temperature increases, the voltage across it reduces and this partly compensates for the similar reduction in Vbe voltage of Q3 and Q4, as they warm up.

The 1Ω emitter resistors apply a small amount of local negative feedback to Q3 and Q4 and this also helps stabilise the quiescent current. By the way, the term "quiescent current" refers to the current drawn by the amplifier when no signal is present. Quiescent current is often referred to as "no signal" current. As soon as signal is applied to the amplifier, more current is drawn.

Negative feedback & stability

The 2.2kΩ resistor connected between the output of the amplifier and the emitter of Q1 forms the negative feedback path. This resistor, together with Q1's 100Ω emitter resistor, sets the AC voltage gain of the amplifier to 23. The associated 47µF capacitor rolls off the bass response below 34Hz.

Note the network consisting of a 10Ω resistor and a 0.1µF capacitor connected across the amplifier's output. Often referred to as a Zobel network, this network helps ensure that the amplifier does not tend to oscillate supersonically when it has no load or when its effective output load becomes a very high value, as it can at high frequencies due to the inductance of a loudspeaker.

Bootstrapping

A point to note is that the 1kΩ resistor in the collector load for Q2 is not connected directly to ground. Instead, it goes to ground via the loudspeaker. To understand why this has been done, it is important to note that the output transistors function as emitter followers and thus have almost unity gain. This means that there is almost no difference in AC signal voltage between Q2's collector and the output to the loudspeaker, and so there is very little AC voltage drop across the 1kΩ resistor.

As a result, Q2's collector "sees" a much higher AC impedance than the nominal 1kΩ load connected. It is therefore able to provide more drive to the output stage and operate with less distortion than would otherwise be the case (eg, if the 1kΩ resistor was connected directly to ground).

This technique is called "bootstrapping" and is commonly used in amplifiers to improve the linearity. However, this simple form of bootstrapping is not used in higher performance amplifiers as it has a serious drawback – if you disconnect the loudspeaker, the 1kΩ resistor has nowhere to go. Thus, the bases of the output transistors are pulled up to the positive supply and the amplifier latches up.

This can be a trap for young players because if you try to make voltage measurements on the circuit without a load connected, the circuit won't work!

Power for the circuit can be derived from any 9-12V DC source capable of supplying up to 100mA (eg, batteries

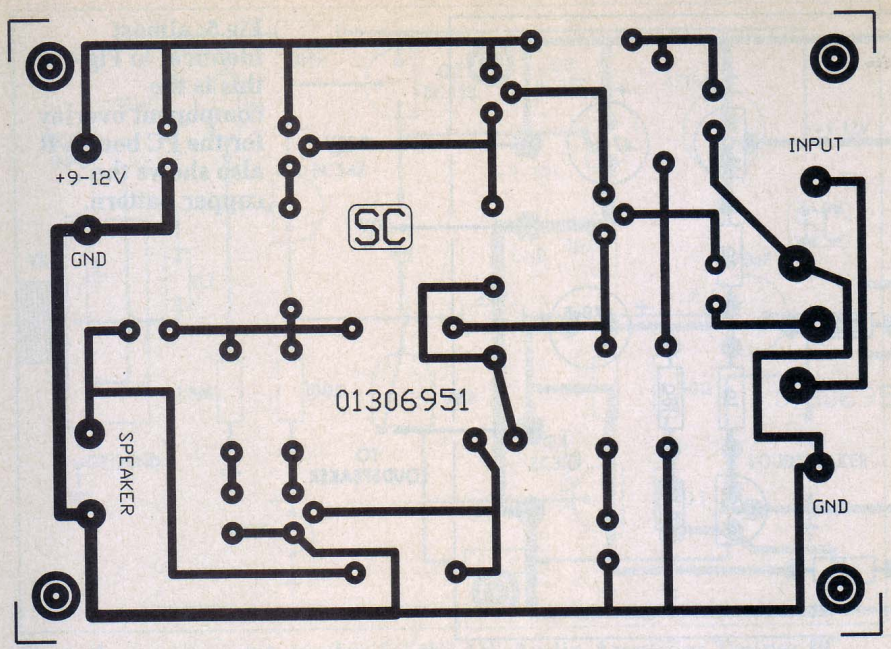


Fig.6: this is the full-size artwork for the PC board.

or a 9V DC plugpack). A 470µF electrolytic capacitor provides supply line filtering, while a 180kΩ resistor and 10µF capacitor provide further supply line decoupling for the bias network connected to Q1. This prevents the output from following any changes to the supply voltage.

Construction

The 1W Audio Amplifier Trainer is constructed on a PC board coded 01306951 and measuring 110 x 78mm. It features a screen printed component overlay on the top side which is very similar to the circuit diagram, as noted above. The screen pattern diagram is shown in Fig.4 while the almost identical component overlay diagram is shown in Fig.5.

Most of the components will go on the board as shown with two exceptions. Transistors Q1 and Q3 will need to have their base leads (centre lead) bent between the other leads to match the holes in the PC board. This is easily accomplished with a pair of pliers.

We used PC stakes for the 9-12V and 0V supply inputs, the loudspeaker outputs and the signal input terminals IN and GND. Use the colour code chart to check each resistor as it is installed. If you are not sure of the values, measure each resistor with your multimeter.

The electrolytic capacitors must be mounted with the correct polarity so that the positive marking on the overlay corresponds to the positive lead on the component. Note that while 16VW electrolytics are specified in the circuit, you may be supplied with 25VW or 35VW capacitors instead. These will be a little larger but will work just as well.

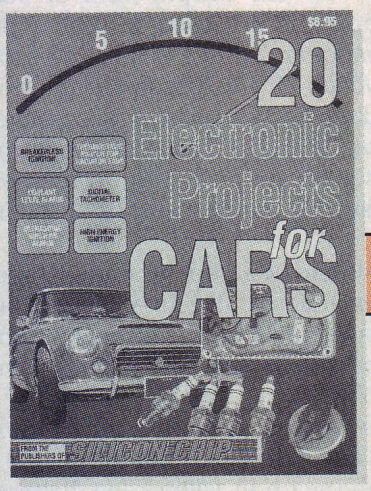
When installing the transistors, be sure to get each one in its correct place otherwise they may be damaged. Make sure that the diode is inserted the correct way around, too.

When all the parts have been installed correctly and soldered in place, check your work again to be sure everything is correct. Now set VR1 fully clockwise. This will minimise the current through Q3 and Q4 when power is applied.

You can now connect up a loudspeaker and apply power. You can use a 12V battery, 12V power supply or a 9-12V DC plugpack. The voltage measurements on the circuit were taken with the supply voltage set to exactly 12V. Connect a multimeter across one of the 1Ω resistors and set the multimeter to read DC mV. Apply power and set VR1 for a reading of around 4mV. This will set the quiescent current through Q3 and Q4 at 4mA.

Now check the other voltages on the circuit to see that they are within 10% of those shown. If they differ widely, you have a problem.

Note that if you use a digital multimeter to measure the voltage at the base of Q1, the value will be loaded slightly by the 10MΩ input impedance of the meter. On other hand, if you use an older analog multimeter to measure this base voltage, its sensitivity is likely to be "20,000 ohms per volt" and thus its loading when set to the a 10V DC range, for example, will be only 200kΩ. This would seriously load down the base of Q1 and thus lead to a wildly inaccurate voltage reading. **SC**



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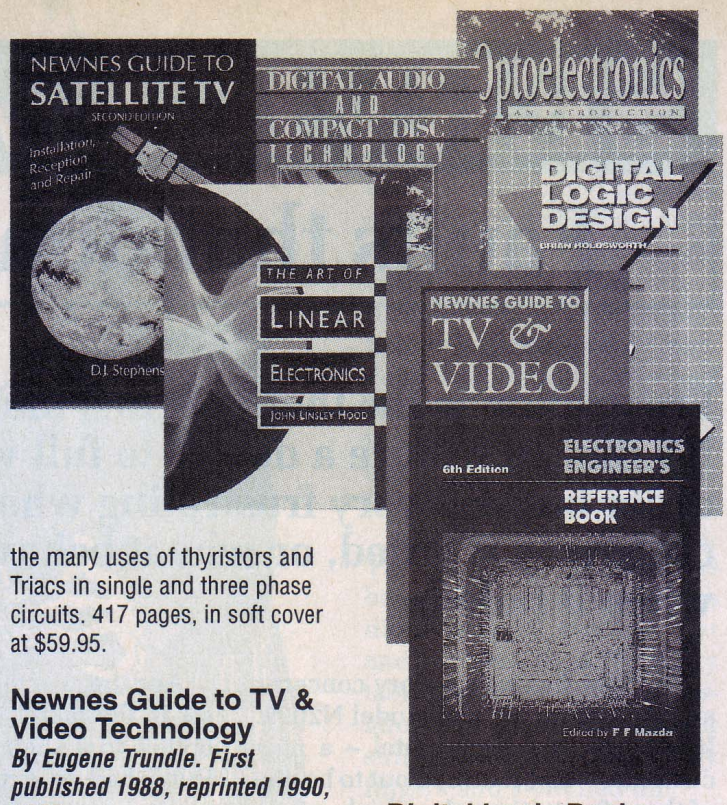

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SERVICEMAN'S LOG

Faults that don't obey the rules

Frustration is the theme of this month's notes. It's nice to restore a device to full working order but still very frustrating when it is not clear why it failed, or why it behaved as it did when it failed.

The first frustrating story concerns an NEC colour TV set, model N2092. It belongs to a local motel – a new customer – and it turned out to be one of those frustrating jobs which, while satisfactorily concluded at customer level, leaves a legacy of doubts and queries as to just why it behaved as it did.

It started with a 9 o'clock phone call from the motel proprietor, asking me to come and have a look at a TV set which, to use his own words, "wasn't going". That expression prompted me to ask whether it was completely dead – an unfortunate phrase perhaps – to which he replied that, yes, it was completely dead.

And he wanted me to service the set in the motel, because the set was bolted to a shelf in the motel room. But I had to explain that I did not make house calls, that service was seldom practical away from the workshop, and that, in any case, the set would have to be unbolted before I could work on it.

For once, I had struck a customer who was quite reasonable about such matters. He appreciated the problems and agreed to bring the set to the shop. However, he did stress that he would like it back that day, if that would be possible.

Naturally, I couldn't make such a promise. But I did say I would look at the set immediately and do what I could, depending on the fault.

All of which doesn't have much to do with technicalities, but is simply an example of the various matters which have to be sorted out before a set is even sighted.

Anyway, the customer turned up a little later with the set in the back of a ute. I set it up on the bench and turned it on while he was there. And that was the first setback. Far from being completely dead, the set was very much alive with a full raster on the screen and a healthy hiss from the speaker. Granted, there was no picture or sound and I suppose, to the customer, it might just as well have been completely dead.

Oh well, my fault for not being more specific. But it did change the situation somewhat. On the positive side it appeared that the rear end was working, particularly the horizontal deflection circuit and all that goes with it. And that, in turn, suggested a front-end fault.

Unfortunately, it also ruled out the chances of a clear-cut fault, as in a completely dead set. And that, in turn, meant that there was less chance of a quick fix and I advised the customer accordingly. Again he was quite understanding and so he left me to it.

When I turned the set on again some time later, it came up as before. Then the phone rang and I turned the sound down to remove the hiss while I dealt with the call. When I eventually returned to the set, it was displaying a first class picture. What's more, the sound had also returned to normal, as I quickly found when I advanced the volume control.

So the fault was intermittent; the last thing I needed when the customer was hoping for a same-day job.

What I did need was a service manual – or at least a circuit. But I had neither. The best I could dig up was a circuit for a similar model, which I felt might be sufficient for the job. In

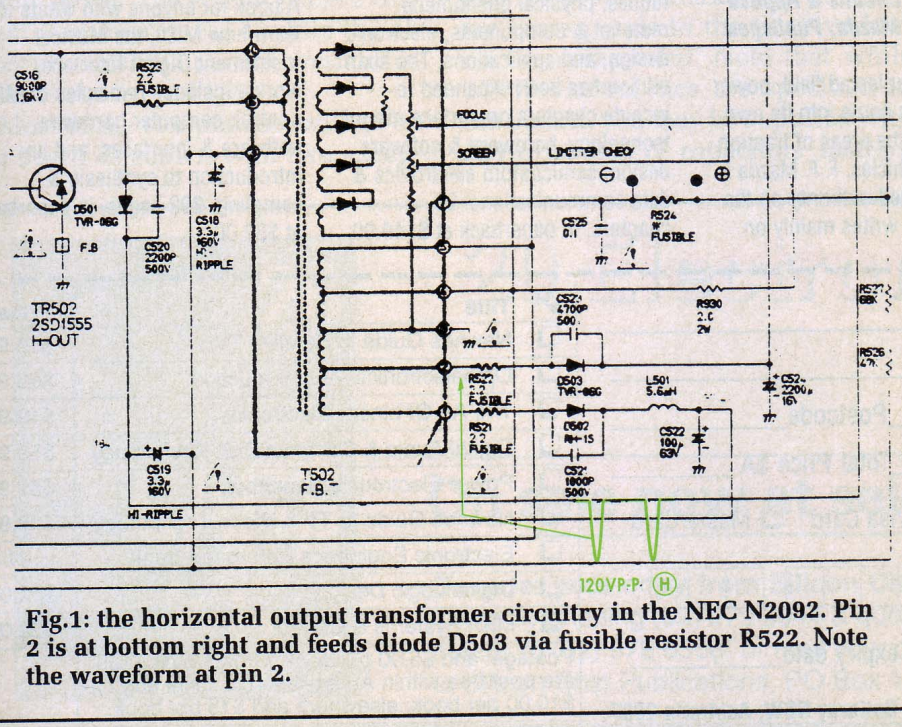


Fig.1: the horizontal output transformer circuitry in the NEC N2092. Pin 2 is at bottom right and feeds diode D503 via fusible resistor R522. Note the waveform at pin 2.

..IT WAS COMPLETELY DEAD

fact it served very well, its main shortcoming being that it lacked any waveforms. Later – much later – I found a colleague with the correct version, complete with waveforms.

The fault returns

The set had been turned off while I was searching for the circuit and, when I turned it on again, it came up in the fault condition. In fact, this was to be the pattern; switch it on from cold and the fault would appear. Then, after anything from a few minutes to half an hour, it would come good. Similarly, once up and running, it would need to be turned off for up to half an hour for the fault to reappear.

This was something of a mixed blessing. It was helpful to be able to create the fault, almost at will, but the half-hour wait each time was highly inconvenient and time-consuming.

I left the set for half an hour or so, while I attended to another, more routine job, then switched it on again. It came up faulty and I quickly switched it off. I then took the back off, pulled the works out, and began finding my way around the boards with the aid of the circuit. And, since it appeared to be a front-end fault, I concentrated on the tuner and IF sections.

Next, I switched the set on again and made some quick voltage checks before it came good. And I hit it almost in one; both the tuner and the IF section are fed from a 12V rail – which didn't have 12V on it. So that was it – all I had to do was find out why there was no 12V. And I was silly enough to imagine that this would be quite straightforward.

It was no problem to trace out the 12V rail on the circuit. It was a conventional arrangement, derived from a tapping (pin 2) on the horizontal output transformer (T502). From this point, there was a 2.2Ω fusible resistor (R522); a diode (D503); a 4700pF capacitor (C523) in parallel with the diode; and the 2200µF main filter capacitor (C524) 2200µF. In short, it was perfectly conventional and it looked like a snack.

I checked the 2.2Ω resistor and the diode but could find nothing wrong with these parts. But I did suspect that there might be a dry joint to one diode lead, so I resoldered these and those of the 2.2Ω resistor.

By this time, the set should have cooled into its fault condition but, when I switched it on, it came good immediately. This seemed like a good omen but I have been caught before in this situation. I turned it off for another half hour to let it really cool down. And, incidentally, these half hour periods were adding up; the day was slipping away and there wasn't much time left if this didn't fix it.

Unfortunately, it didn't. The set came up faulty as before. So what next? The diode seemed the best bet and, to save time, I simply tacked another diode in parallel with it on the copper side of the board, crossed my fingers and switched on.

The result was completely unexpected. The set really was completely dead now; no raster, nor sound hiss, no sign of life at all. After the first shock, I did some probing with the meter and eventually realised that there now virtually a dead short on the 12V rail, with only a couple of ohms to chassis.

And so began the laborious task of tracing the 12V rail and isolating various sections in an effort to pinpoint this fault. Naturally, as readers can imagine, tracing this rail on the circuit is one thing; tracing it in reality is something quite different. It weaved and wandered all over the place and was almost impossible to follow in places.

The only good point was that it used a number of links and these proved valuable in isolating various sections. I think I lifted about five links altogether and, including inevitable interruptions, spent about two hours tracking it down.

The faulty parts

The faulty components were associated with pin 38 of the jungle chip, uPC1420CA. This pin is fed from the 12V rail via isolating diode D504. Also connected to it is zener diode ZD501 and resistor R514 (12kΩ, 2W). The other end of this resistor connects to the 120V rail. This is the kick-start network, which is needed to start the

horizontal oscillator at switch on.

Both D504 and ZD501 were shot (dead short) and this was what was loading the 12V rail. Why had this happened? I have absolutely no idea. Naturally, I checked the substitute diode and anything else that I might have done wrong. I drew a blank on all counts.

So all I could do was replace these two components and try again. I replaced the main diode (D503) and removed the substitute diode I had shunted across it, then I switched it on again. Well, at least the set was "alive" (raster and hiss) but there was still no 12V. Then I realised that the 2.2Ω fusible resistor had done its job and fused.

I fitted a new resistor and tried again – still no 12V rail. I went over everything again, checking and double checking, but could find nothing wrong. But I did realise that something else had happened; no practical warm-up period would now cure the fault and it appeared to be permanent.

Well, that could be all to the good. And, having checked everything else, the main suspect now was the horizontal output transformer, unpleasant though this thought was.

With the frequency and waveform involved here, the only practical way to check this is with a CRO. But even here I had a problem. As I mentioned earlier, I was working from a circuit which had no waveforms. So I had only a very general idea of what I would find on pin 2.

In fact, there was a waveform there and its shape was not unreasonable. But I had no clue as to what the amplitude should be and it was rather beyond my grocery bill mathematics to work out what it should be to deliver the required 12V.

But I did suspect that it was rather low, which only supported my impression that there was some kind of weird fault in the transformer. I finished up disconnecting it entirely and making resistance checks on all the tappings. They all showed continuity and appeared to make reasonable sense, at least as far as I could tell without any precise reference.

Finally, I pulled the transformer out and checked it on the shorted turns tester. Again I drew a blank. Nevertheless, I had now convinced myself that the transformer had to be the culprit.

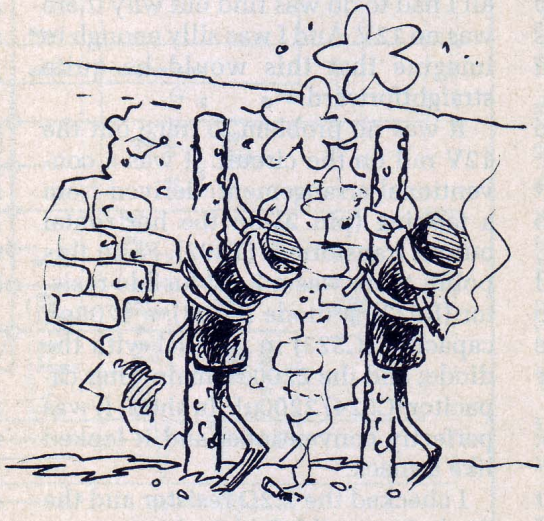
Good news & bad

On that basis, the next step was to check availability and replacement cost. A call to the NEC service department produced a good-news-bad-news reply. The good news was that replacements were available and the bad news was the retail price of $166. For most sets, the cost would range from about $60 to $100, so this was a real shocker, particularly as there was still a niggling doubt as to whether I was really on the right track.

But I had more or less committed myself now, so it was up the motel proprietor. I rang him, explained that the job was going to take longer than we had hoped and that it was going to be quite expensive. By the time the transformer price, labour and other costs were added in, the bill would be over $250. Did he want to go ahead?

He thought about it briefly, then said, "yes, go ahead". As he explained it, there were a couple of factors involved. One was the alternative cost – it would cost a good deal more to replace the set and it was an essential item.

The other reason was more unusual. When the motel had been fitted out, the cabinet colours had been specially chosen and supplied to suit the decor (it was a light cream colour that was not normally available). This could be difficult and expensive to replace.



So I ordered the transformer, which arrived in a couple of days, and cost another $8 freight. And from there it was something of an anticlimax; I fitted it, switched on, and the set snapped into life with perfect picture and sound. Of course, I gave it a thorough workout, with a routine of on-off cycles over the next couple of days. But it never missed a beat and hasn't missed one since.

Unanswered questions

So that was it; a faulty transformer. The set went back to the motel and I had a happy customer, in spite of the cost. But, as readers will agree, it leaves a lot of questions unanswered.

For a start, what kind of fault was it? Remember, it produced what appeared to be a typical waveform at pin 2, even though there was no DC after the rectifier.

The best suggestion I can make is that it was some form of high internal resistance, intermittent, and probably non-linear in some way. In other words, it was incapable of supplying any useful current to the load but could still produce a waveform of sorts on a sensitive CRO.

Further to that last thought, it was only when the job was finished and the set back in the motel that I found a colleague with the correct circuit. And it is the appropriate portion of that circuit which is reproduced here.

The waveform shown for pin 2 is essentially the same shape as that which I observed for the faulty transformer. But the amplitude is another matter. I didn't take as much notice of it as I should have but, as I recall, it was nothing like the 120V p-p as on the circuit.

And what about the destruction of the diode and the zener diode? This is an even greater mystery. My best suggestion here is that the substitute diode I shunted across the original was faulty and was breaking down at high voltage.

OK, so it's a long shot. But I am sure of one thing – if one such

faulty diode existed in a batch of ten million, it would finish up in my spare parts stock.

The microwave oven

And now for the second spot of frustration. This involves a complete change of scene; from a colour TV set to a microwave oven, and an intermittent one to boot. This was a first for me. Until now, I've had intermittent faults in every device I can think of except a microwave oven.

It started with a phone call from a regular customer and concerns a Panasonic model NN-9859. This is a combination microwave and convection heating type and, in order to appreciate the problem, it may help to describe the operating procedure, particularly for the convection mode.

Having turned the oven on, the required temperature is selected by pressing an appropriate key, which increments the temperature indicator in 10°C steps. When the oven reaches the preset temperature, the system beeps and flashes the temperature indicator. The oven is then held at that temperature.

The customer's complaint was that, having gone through this procedure in the convection mode, the oven would behave normally for about five minutes and then shut down. If the start button was then pressed, it would run for another few minutes, then shut down again. This procedure might need to be repeated several times but, eventually, the oven would come good and run as long as needed.

I immediately enquired as to whether this also happened in the microwave mode, thus suggesting a common fault area. But he couldn't say; they seldom used the microwave mode, only the convection mode. The microwave mode was used on the odd occasion to reheat a cold meal but then the time needed was probably too short to create the problem.

So I said, "bring it in and we'll have a look at it". And so it finished up on the bench. I deliberately avoided removing the covers, so as not to disturb anything, but simply switched it on, set it up for a couple of hundred degrees, and let it run.

And it ran perfectly; not a sign of trouble. I switched to microwave mode, added a jug of water as a dummy load, and tried that. Again, it ran perfectly.

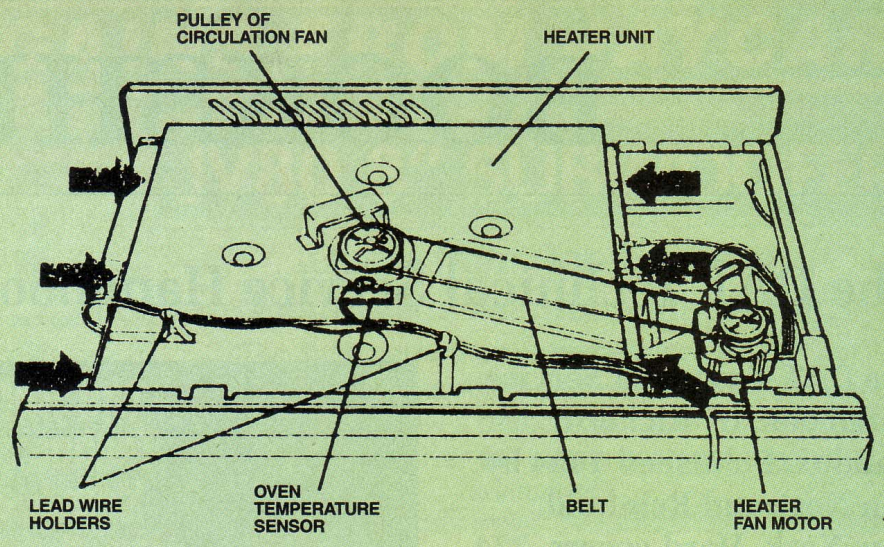


Fig.2: this drawing from the service manual shows the top of the Panasonic NN-9859 with the cover removed. Note the temperature sensor below the circulation fan pulley.

I turned it off, let it cool for a couple of hours, then tried the convection mode again. And this time it did misbehave; it ran for a couple of minutes and then shut down. The temperature display was still showing the correct value and pressing the start button set it off again.

And, just as the customer had said, I had to do this two or three times. Then it came good and ran up to the selected temperature. I repeated the test in the microwave mode and it behaved perfectly.

I let it cool overnight and repeated the tests the next day. The result was exactly the same as before; intermittent on convection, perfect on microwave. On the face of it, it looked like a nasty problem. And it could have been, had I not serviced this model and earlier models before. Which is not to say that I had seen this problem before – I hadn't.

But I had encountered a fairly common fault whereby the display panel would exhibit a string of eights, which meant that the oven could not be programmed for either mode. And the reason? An open circuit oven temperature sensor.

So, while the symptoms differed, I went straight to this sensor. This looks like a ceramic encased resistor and is mounted on a ceramic strip. This in turn mounts over an opening in the top of the oven, with the sensor below it. The sensor connections consist of two flat metal lugs, to which are connected leads which run back to the microprocessor.

In all the units I had seen before, these lugs were about 75mm long and were encased in insulating sleeving which extended back over the connecting leads. They were also bent parallel with the top of the oven. In this oven, however, the lugs were only a few millimetres long and the connections to the leads were plainly visible.

And so was the fault. Instead of the usual welded or staked connections, these looked as though they had been soldered. But there was little solder to be seen now. The lugs were blackened and the tinned leads simply wrapped around them. The wonder was that the thing worked at all.

For a start, soft soldered connections on those lugs simply do not make sense. The oven is programmed up to 250°C and would commonly run at up to 200°C, so the sensor and its lugs would also be heated to that level. Against this, the melting point of 60/40 solder is around 190°C or even a little less, creating a completely incompatible situation.

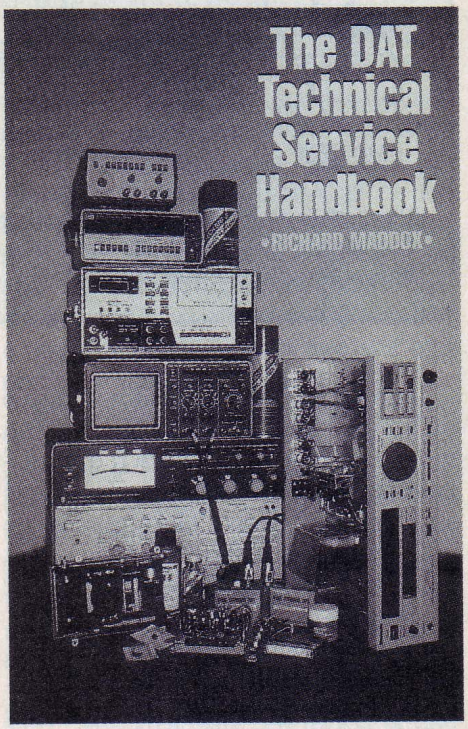
My bet is that it was bodgie repair. The original sensor probably failed and some smart type salvaged a sensor from a ditched oven, clipping the lugs short in the process. He then attempted to solder the unsolderable, creating the ultimate in dry joints.

I can't prove it of course but it's the best theory I can come up with. **SC**

BOOKSHELF

The DAT Technical Service Handbook

The DAT Technical Service Handbook, by Richard Maddox. Published 1994 by Van Nostrand Reinhold, New York. Hard covers, 224 pages, 235 x 156mm, ISBN 0-442-01423-6. Price $109.95.



Not a book for the beginner, this text is more for the person who has been carrying out maintenance or service on analog or video tape recorders and who now wishes to gain some knowledge of Digital Audio Tape (DAT) recorders.

The Author was introduced to his first DAT machine in 1989 and has been concerned with maintaining them ever since. The book is divided into nine chapters plus three appendices.

Chapter 1 traces the development of digital audio tape from 1983 when the Sony RDAT (rotary head DAT as in VCR's) was selected as superior to the SDAT format (ie, stationary head DAT as in analog tape recorders) due among other factors to tape size, recording time and error correction. This chapter also discusses the origin of DAT copy protection, consumer versus professional decks and the tape format.

Chapter 2 covers DAT recording specifications, the track section identification, the rotary transformer which gets the information from the spinning heads to the electronics, methods of head switching, automatic track finding (ATF), servo systems which keep the heads spinning at 2000 RPM for record and playback but allow small variations under the control of ATF and finally, brief coverage of analog-to-digital and digital-to-analog converters.

Chapter 3 gets into the nitty-gritty of maintenance and service, which is what the book should be all about. The Author covers the tools, test tapes and equipment necessary to do the job adequately. He stresses the necessity for regular maintenance and the critical nature of the alignment of the tape path, as each track is only 1/10th the width of a human hair. He also lists the items that need regular replacement.

Chapter 4 covers alignment procedures, including tape tension, capstan adjustment, RF record and playback. It also includes a summary of the different alignment tapes available. Chapter 5 discusses the mechanical side of the DAT machine: the transport mechanism, head drum maintenance and wear, dismantling and reassembling transport mechanisms and some replacement procedures for specific models.

Chapter 6 is probably the chapter of most interest to our readers. It covers the signal flow through the recorder, starting with the analog inputs, analog-to-digital (A/D) conversion, signal processing blocks, digital-to-analog (D/A) conversion, RF circuit details and servo circuits. The Author finishes the chapter by saying that although the information was for the Panasonic SV-3900 it is mostly applicable to the SV-3700 as well. Also the transport and much of the control circuits discussed are used in the Panasonic SV-3200 and Technics SV-DA10 recorders. The Studer D-780DAT uses the Technics transport and Studer electronics.

Chapter 7 covers fault finding and as is the case with electronic equipment that has a complex transport mechanism, this usually causes most of the problems. Richard Maddox has found DAT recorders are no exception. The major problem, in his experience, is tracking incompatibility between machines due to misalignment and head wear.

Chapter 8 is headed "Errors And Other Causes Of Headaches". Because the tape is moving at 0.32 inches per second (about 8 mm per second – yes, it's an American book) and recording 61K bits per inch (approx 2400 bits per mm), you can well imagine how critical the alignment is and how a little wear could cause problems.

Chapter 9 covers servicing tips for various models including Aiwa, JVC, Marantz, Panasonic, Studer, Tascam and Technics machines. For anyone maintaining one or more of these machines, the book could be a wise investment.

The book finishes with three appendices. The first covers DAT abbreviations, as these will not be familiar to the beginner (eg, ADLRCK – Analog to digital left/right sample clock; and MASH – Multistage noise shaping). The second is a DAT glossary and the last, a bibliography.

To sum up, this is not a book for everyone but those in the field will benefit from it. Our copy came direct from the publishers, Thomas Nelson Australia, 12 Dodds Street, South Melbourne, Vic 3205. Phone (03) 685 4111. (R.J.W.)

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JUNE BARGAINS FROM JAYCAR

Jaycar Vifa

AS REVIEWED IN ELECTRONICS AUSTRALIA JUNE 1995

JV80 8" SUBWOOFER

The driver used in this subwoofer is the fabulous new Vifa M22WR 8" driver. It incorporates a long stroke, low reflection magnesium basket, has a 50mm voice coil and a very stiff conical paper cone with a low damping rubber surround. Power handling is an amazing 150WRMS. Please contact us for a copy of the article from Electronics Australia if you don't have it.

Quote from Rob Evans in Electronics Australia Magazine.

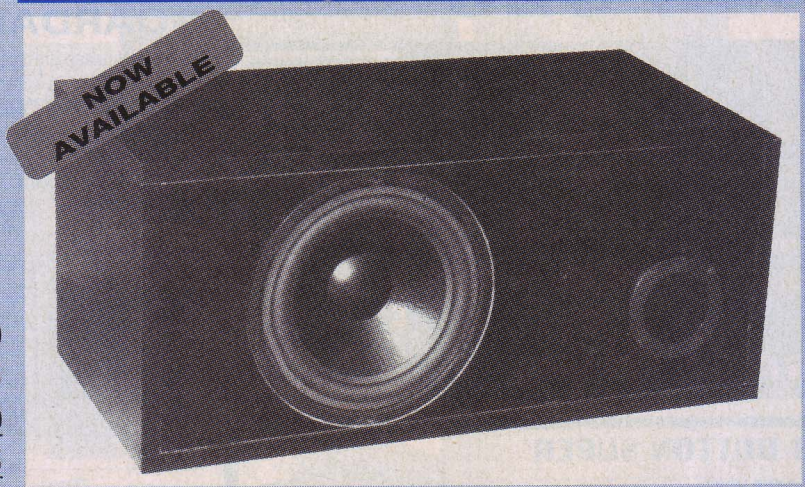
"The JV80 performed extremely well in both our subjective and objective tests, and really did demonstrate how a refined driver such as the Vifa M22WR can deliver the goods in a correctly tuned enclosure".

NEW

The cabinet is supplied prebuilt and is made from MDF in blackwood veneer. Grill is supplied with speaker cloth mounted. Cabinet size is very small, with a volume of 35 litres, and measures 600 x 270 x 300mm. We recommend a polyswitch speaker protector to help protect the driver.

Check with your local Jaycar store for a demo. Demos in most stores.

Speaker - Vifa M22WR Cat. CW-2115	$199.50
Polyswitch Cat. RN-3472	$10.95
Cabinet Cat. CS-2540	$139.00
	Total $349.45



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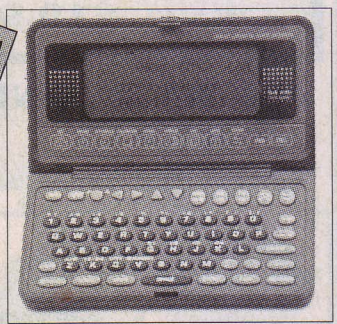
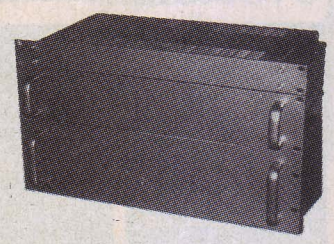


PRO RACK CASE SELLOUT



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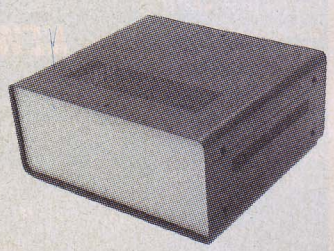

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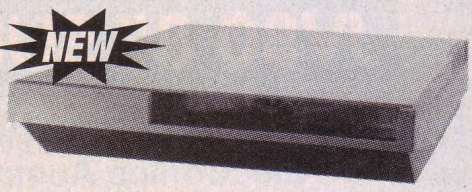

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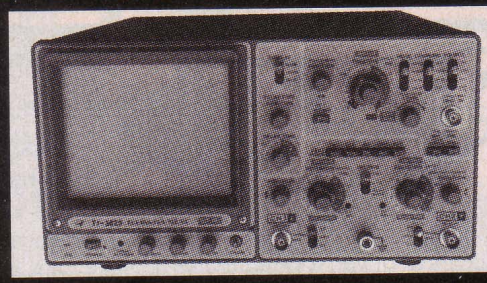

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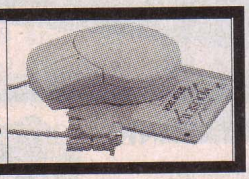

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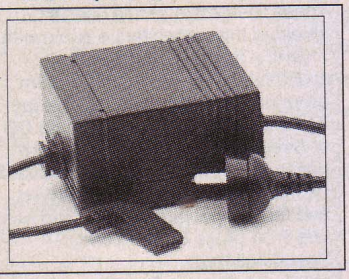

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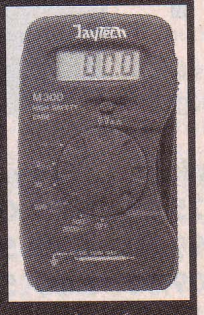

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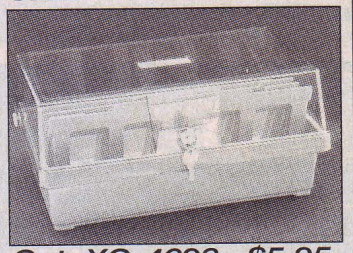

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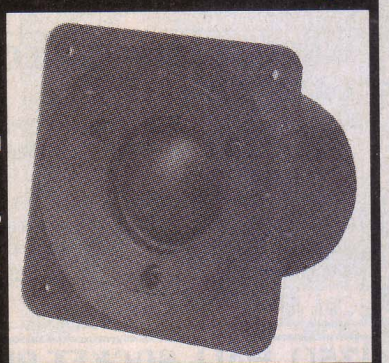

Yes this driver does bear a striking resemblance to the Philips AD02110/Sq8 and the difference does not end there. Our evaluation of samples gave very pleasing results. Not as good as the Philips driver , but if your budget does not extend to the European import, you can get two of these for around the same price. •Nom impedance- 8 ohms •Power handling- 120 watts rms (system) •Frequency range- 600Hz - 10000Hz •Sensitivity- 88dB 1watt 1metre. •Voice Coil Resistance (Re)- 6.9Ω. •Total Q factor (Qts)- 0.483 •Resonant frequency (fs)- 405 Hz.

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This budget model has the following features •full logic micro cassette deck •micro-processor control •optional remote control •remote turn on •memo recording facility •call screening •message received indicator/counter •variable length outgoing message •rewind, playback and fast forward •volume control.
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True Mains Power from a battery..... A sinewave inverter generates mains type power with the correct peak and mean voltages guaranteeing reliable, optimum performance for the connected electrical equipment.
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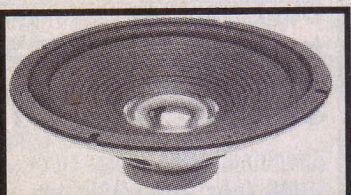
TWELVE MONTHS WARRANTY

Cat. MI-5030 **WAS $699 SAVE $100 ONLY $599**

10" Black Cone Woofer Sellout



This is a quality woofer with foam roll surround, silver dust cover and grey ribbed cardboard cone. Listed below are all the specifications we have available.•Impedance: 8Ω •Power Handling: 60 watts •Resonant Freq. (approx): 38Hz •Frequency Response: 38 - 3kHz •Suitable Enclosure: 25L or more - sealed

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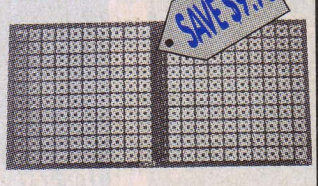
NOW $14.95 SAVE $3

PCB BARGAIN

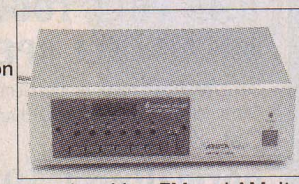


This board is ideal for mounting larger components, e.g. relays, large electros, bridge rectifiers, etc. The pattern is arranged on a copper clad "square" with holes on a 0.2" (5mm) square pitch. Soldering components to any "square" automatically connects them to 3 other points. 20 holes x 20 holes, positions marked alpha numerically. 88 x 88mm. (Supplied as a snap-apart pair 88 x 176 long).

Cat. HP-9560 **WAS $3.95ea**

NOW 5 FOR $10

AM/FM TUNER BARGAIN



Strictly Limited Quantity available. This tuner will work on both 240VAC and 12VDC. Six stations can be preset and selected by push buttons. These stations can be either FM and AM. It is designed to be used in a restaurant or outdoor PA system. It can be used on your normal stereo, however both FM and AM signals are mono. The recommended sell price is $309. Size 265(W) x 195(D) x 80(H)mm. Because they are such a bargain, we cannot offer our normal warranty. We will however offer a 7 day warranty.

Cat. AR-2250 **only $59**

SAVE ABOUT $250!!!

JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRO
JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRO

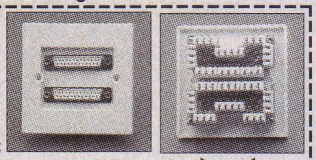
AYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS JAYCAR ELECTRONICS

ABS PLASTIC BOX

Made in the U.K. from ABS. Has a precision fitting moulded lid with metal bushes to take countersunk screws (supplied). Its about the same size as the largest size Jiffy Box. Measures 190(L) x 110(W) x 60(D)mm. Jiffy box sells for $6.75.
BUY THESE FOR ONLY $3.95 EACH.
Normally sells for around $12. Colours available: white, blue and orange.

Cat. HB-5504 **Only $3.95 ea**

D-SUB SPEED CONNECT DATA PORT



Another surplus buy. Made in the U.K. These ports provide the user/installer with a simple system for installation of "D" connectors. The IDC feature eliminates soldering, and wires can be quickly disconnected and rewired to new pins if required. Inserting wires is made easier if you have a BT inserter tool. Faceplate is UK power point size ie 85 x 85mm - white in colour. Fitted with 2 x D25 females. LIMITED QUANTITY AVAILABLE.

NEW

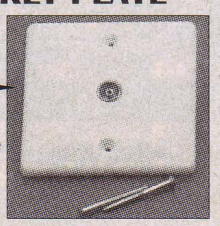
Cat. PP-0859 **only $5 ea**

Save $30 On Car Speaker Kit

The system consists of 6.5" woofer, and a Neodidyium Super Tweeter with a high power crossover. They handle high power, so require a power amp of at least 30WRMS per channel to drive them properly. 10 watts is not enough!
SPECIFICATIONS:
•Power handling - 80WRMS/240W PMPO •Impedance - 4 ohms •Freq resp - 50 to 22,000Hz •Sensitivity: 90dB 1 watt 1 metre •Resonant frequency (fs): 50Hz •Sound pressure level - 90dB •Woofer - 6.5" with treated paper cone and rubber surround, magnet weight - 10 ounce, voice coil dia 25mm •Tweeter - Super tweeter with surface mount design. Small size with great response •Crossovers - High power units with crossover frequency of 2500Hz. Each housed in its own case.
Supplied with metal grills for woofer and mounting screws/cables etc. A quality set of speakers that will give you years of excellent service. Add to this a Subwoofer for excellent car Hi Fi sound.

Cat CS-2275 was $199.50 pr **JUNE $169.50 PR**

75Ω WALL SOCKET PLATE BARGAIN

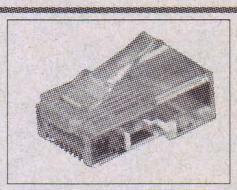


NEW

These have a standard 75 ohm socket in the centre of a square plate. They are not the standard power point size, but they are cheap!
Plate size: 85 x 85mm. Colour white.

Cat. LT-3028 **only $2 ea**

TELEPHONE PLUG 8/8 RJ45 SPECIAL



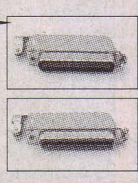
ATTENTION COMPUTER INSTALLERS
These are NOT AUSTEL APPROVED. We are selling these in bags of 50 pieces. Save a fortune over normal prices.
NORMALLY AROUND $1.00 EACH

NEW

Cat. PP-1436 **$17.95 pkt 50**

50 PIN CENTRONICS/SCSI CONNECTORS

NEW

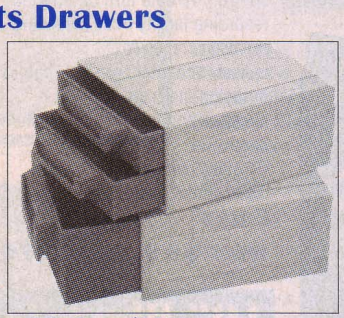


Right angle entry, complete with metal backshells.

Cat. PP-0891 Male **$3.95**
Cat. PS-0899 Female **$3.95**

BUY 10 LESS 10%

Save On Interlocking Parts Drawers

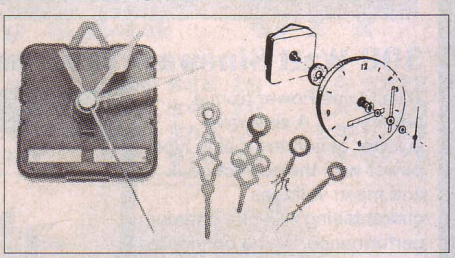


Unique side and top/bottom keying system allows you to use just a few or build a whole wall of drawers as your parts expansion dictates. Quality designed drawer slides will not 'stick' or seize. Slide handles also takes identity cards. Single or double drawers available.
Size: 110(W) x 120(D) x 50(H)mm

SINGLE DRAWER Cat. HB-6300
Normally **$5.95**
JUNE $4.75 or 10 FOR $40

DUAL DRAWER Cat. HB-6301
Normally **$6.20** **JUNE $5.00 or 10 for $45**

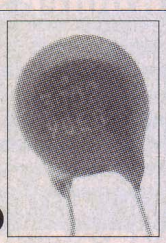
Clock Movement



•Very compact 56 x 56 x 15mm •Self starting one second stepping motor •Uses 1 x AA battery that lasts 1 year •±15 second/month accuracy •Supplied with three sets of hands •Includes sweep second hand

Cat. XC-0100 **only $9.95**

300VAC VARISTOR BARGAIN

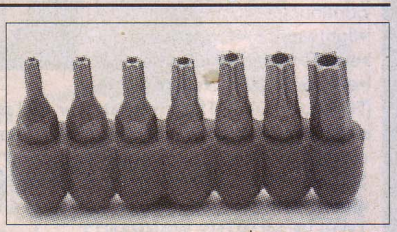


Specifications: •Dia: 7mm
•RMS Volts: 300 •DCV: 405
•Joule: 25 •Peak Current: 1200A
•Capacitance: 70pf

NEW

Cat. RN-3402 **$1.50**

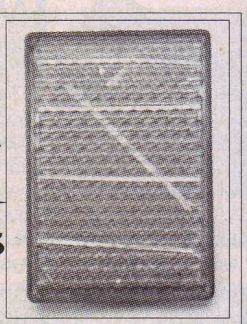
Tamper Proof Torx Screw Bit Set



The set consists of 7 Tamper Proof Star pieces which fit the 6 point STAR type screws with tamper proof pins, as those found on computer systems etc. They are T10, T15, T20, T25, T27, T30, T40. Made from chrome vanadium - steel and heat treated.

Cat. TD-2034 **$14.95**

0.45 VOLT 1000MA SOLAR CELL SPECIAL



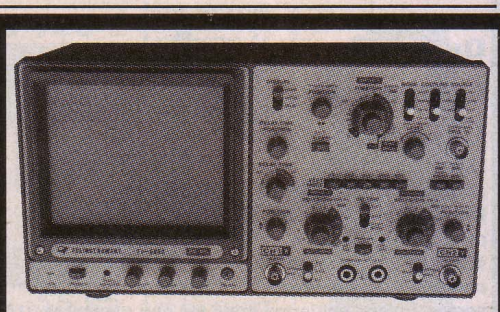
Ideal for experimentors. Connect in series or parallel. Terminal strap enables easy connection to other cells.
Cat. ZM-9004

normally $7.50

SAVE

JUNE ONLY $4.95
SAVE $2.55

2 FREE PROBES WITH 25MHZ CRO PURCHASE



The Jaycar 25mHz Dual Trace CRO features delayed sweep. Most other CROs are 20mHz, our is 25mHz. See 1995 catalogue page 35 for details and specifications.

Cat. QC-1900 only $749

June - 2 probes supplied free, value $79

JAYCAR SELLS FOR LESS COMPARE OUR PRICES

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LATEST JAYCAR KITS

Playmaster 300W Subwoofer Amp Kit

NEW

REF: ELECTRONICS AUST APRIL / MAY 1995

Cat. KA-1770

$349

Mini Spot AM/FM Alignment - Source Kit

NEW

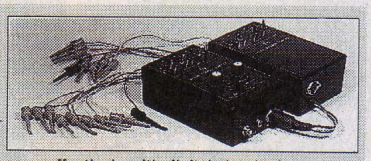
REF: EA 4/95

This kit will provide both a 455kHz signal for aligning AM radio IF strips and a 10.7MHz signal for doing the same job on FM radios. Both signals are modulated with an audio tone of around 1kHz, with the 1kHz audio signal available by itself for audio testing. The Jaycar kit is complete with PCB, case, silk screened front panel, plus all electronic components. Three AA penlight batteries required. Use Cat. SB-2354 Pk4

Cat. KA-1796 **$23.95**

Digital Trigger Adaptor Kit For CRO's

NEW



REF: EA 4/95

This project allows you to use your CRO more effectively with digital circuits by allowing you to monitor any given event in the circuit under test, and to trigger the scope only when all the relevant input conditions are met. With eight inputs (expandable to 24), it also includes an adjustable trigger delay, so it can effectively convert your scope into a low cost logic analyser. Kit is complete with PCB, case, screen printed front panel, IC test clips plus all electronic components.

Cat. KA-1772 **$55.00**

Dolby Pro Logic Surround Sound Kit

REF: SILICON CHIP DEC 94 / JAN 95

Short Form Kit

DOLBY SURROUND PRO • LOGIC

This kit is supplied with pre-tinned PCB, Dolby ICs and all electronic components as per the Silicon Chip article, RCA socket bank, potentiometers, switches and internal audio and mains cable. The short form version of the kit is ideal for those constructors who wish to build a complete decoder with amplifier modules in the same case as the decoder. **EXCLUSIVE TO JAYCAR.**

Cat. KC-5175 **$169.50**

Enclosure Kit

This includes the low radiation toroidal transformer, mains lead and plug, fuse holder and fuse, mains switch, black anodised brushed aluminium instrument knobs, professionally punched and screened front panel, punched rear panel plus all mounting hardware.

Cat. KC-5176 **$69.50**

Economy Surround Sound Decoder Kit

NEW

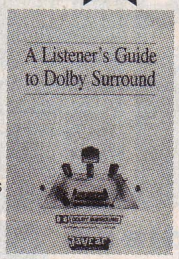
REF: EA 5/95

This surround decoder uses low distortion analogue circuitry to produce a surround channel, centre channel and subwoofer output channel. If our genuine Dolby Pro-Logic decoder (KC5175) is out of your price range, then this economy decoder is worth considering. The Jaycar kit is 100% complete with case, PCB, punched & silkscreened front panel, punched rear panel, transformer, RCA sockets plus all elec components as per the EA article.

Cat. KA-1773 **$59.50**

A Listeners Guide To Dolby Surround Book

NEW



If you are planning a home theatre for your home, then this guide is essential. It covers all aspects of what you need to set up, and get the most out of a home theatre system. Topics covered:
•Speaker placement •Subwoofers •Surround and centre channel speakers •Power amplifiers •Enhancements for movie viewing - plus much more! This book will answer virtually any question you may have regarding Pro Logic Surround Sound. Don't be left behind - the home theatre revolution is here! 11 pages with fully illustrated pictures. Size: 210mm x 295mm.

Cat. BC-1200 **only $2.95**

D41264C-15 RAM

NEC BRAND - LIMITED QTY AVAILABLE

Cat. ZZ-8520

only $8.95 ea

Jaycar Has All Your Plugpack Requirements

- **•12VDC 150mA.** With 7 reversable plugs — Cat. MP-3002 **$10.95**
- **•9VDC 150mA.** With 7 reversable plugs — Cat. MP-3003 **$10.95**
- **•12VDC 300mA.** With 2.5mm DC plug — Cat. MP-3006 **$14.95**
- **•9VDC 300mA.** Supplied with 2.5mm DC plug — Cat. MP-3007 **$14.95**
- **•9VDC 800mA.** 2.1mm reversable DC plug — Cat. MP-3008 **$22.95**
- **•3, 4.5, 6, 7.5, 9 & 12VDC 300mA.** Supplied with 7 reversable plugs — Cat. MP-3010 **$19.95**
- **•3, 4.5, 6, 7.5, 9 & 12VDC 500mA.** Supplied with 7 reversable plugs — Cat. MP-3012 **$23.95**
- **•12VDC 1 amp.** 2.5mm reversable DC plug — Cat. MP-3015 **$22.95**
- **•3, 4.5, 6, 7.5, 9 & 12VDC 1 amp.** Supplied with 7 reversable plugs — Cat. MP-3016 **$29.95**
- **•12VAC 500mA.** 3.5mm DC removable plug — Cat. MP-3020 **$16.95**
- **•16VAC 1.25 amp.** Terminates to bare ends — Cat. MP-3021 **$21.50**
- **•17VAC 1.5 amp** -earth connected (Austel approved for use with alarm diallers. Terminates to bare ends — Cat. MP-3022 **$24.95**
- **•10VAC 1 amp.** Terminates to 2.1mm reversable DC plug — Cat. MP-3025 **$21.50**
- **•12VAC 1 amp.** Terminates to 2.5mm reversable DC plug — Cat. MP-3026 **$21.50**

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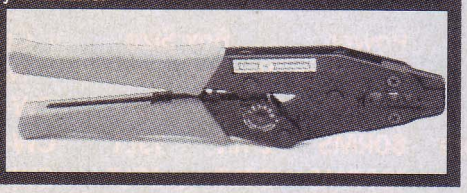
DELUXE CRIMPING TOOL

SAVE $10

These tools are about half normal price. We purchased them from a tool importer who ordered the incorrect one.

This tool will crimp coaxial connectors used with the following cables - RG58, RG59 and RG62. Actual sizes are 8.1mm, 6.5mm, 5.4mm, 2.35mm and 1.72mm. There is also a pressure adjustment control. Limited quantity available.

Cat. TH-1882
Was selling For $49.95
LAST FEW LEFT
ONLY $39.95



Solar Battery Charger for 2 x C Size or Sub C

This solar NiCad battery charger will charge 2 x C size, Sub C or AA batteries. Ideal for anywhere where 240 volts is not available. The solar panel is mounted in the lid, which is removeable from the charger. Also included is a circuit test button. Size 119(L) x 65(W) x 39(H)mm

Cat. MB-3501 **WAS $16.95**
NOW $12.95 **SAVE $4.00**

DESKTOP COPYHOLDER

This copyholder is fully adjustable for personal comfort. It has a tilting bail at the back to vary the reading angle and height adjustable document clip for different sized paper from A4 to foolscap to legal (up to 370 x 220mm).There is also a sliding rule. Colour is black.

Cat. XC-5152 **WAS $14.95**
NOW $10 **SAVE $5**

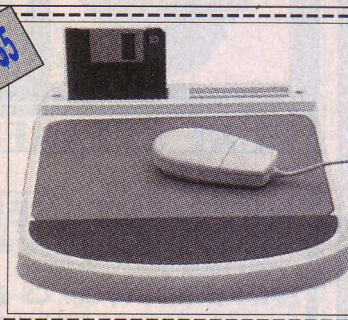
Foot Rest

This foot rest is designed for computer operators, and is suitable for anyone who sits at a desk. The footpad measures 420(W) x 280(H)mm, and is ribbed. The angle of the pad is easily adjustable (by your feet). Its simple to assemble and is grey in colour.

Cat. XC-5160 WAS $22.95
NOW $16.95 SAVE $6.00

Mouse Station

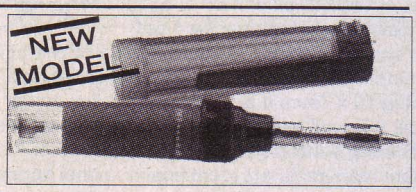
SAVE $5



Mouse station is ergonomically designed to rest your wrist and reduce the risk of Carpal Tunnel syndrome. As well as the padded wrist support, it includes a mouse pad and a slide out drawer at the rear. The drawer will hold 10 x 3.5" floppy disks plus pens etc. Total size 350(D) x258(W)mm. Mouse and disk not supplied.

Cat. XM-5098 **WAS $19.95**
NOW $14.95 SAVE $5

FREE GAS WITH HOT SOL



Buy a Hot Sol Gas Soldering Iron or Hot Sol Service Kit in June and receive a free can of gas. Value $5.95. See catalogue for full details on Hot Sols.

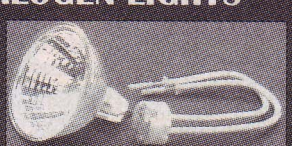
HOT SOL
Cat. TS-1700 **$32.95**

HOT SOL SERVICE KIT
Cat. TS-1702 **$49.95**

Lower Prices On SONY DISKS

Size	Cat	Was	Now (Box 10)
3.5" DSDD	XC-4750	$17.95	$15.95
3.5" DSDD IBM	XC-4751	$19.95	$17.95
3.5" DSHD	XC-4752	$24.95	$17.95
3.5" DSHD IBM	XC-4753	$26.95	$19.95

MAKE UP YOUR OWN 12V HALOGEN LIGHTS WITH OUR BASE!



Normally halogen globes come with a round metal fitting for mounting in the ceiling. But, with our base, you can now mount these versatile lights anyhere. We also sell the 20W and 50 lights.

BASE
Size: 17D x 9Hmm Cable Length: 120mm
Cat. SL-2735 **$2.95**

20W GLOBE/REFLECTOR
Cat. SL-2730 **$7.95**

50W GLOBE/REFLECTOR
Cat. SL-2732 **$7.95**

BUY 10 LESS 10%

WHITE BOX DISKS

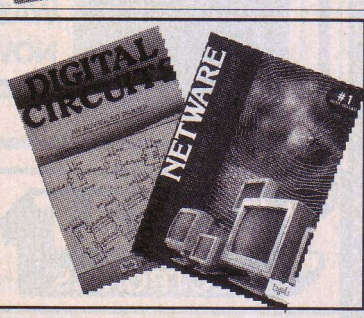
Our standard white box disks have a **lifetime guarantee** and meet 45/20 (ANSI) clipping level. Beware of others selling "B" grade disks. You may save $1 - $2 per box, but when up to 30% may not work, where is the savings? Supplied with envelope, index labels and write-protect tabs.

3.5" DSDD	Cat. XC-4736	PKT 10	$5.95
3.5" DSHD	Cat. XC-4738	PKT 10	$5.95
3.5" DSHD - IBM	Cat. XC-4739	PKT 10	$6.25
5.25" DSDD	Cat. XC-4730	PKT 10	$4.50
5.25" DSHD	Cat. XC-4732	PKT 10	$6.95

THE LATEST BOOKS

SEE MAY ADS FOR FULL DETAILS

Linear IC's and Applications	BM-2489	$17.95
Satellite & Cable TV	BM-2490	$19.95
Digital Circuits	BM-2491	$22.95
Computer Fundamentals	BM-2147	$22.95
All About Monitors	BM-2145	$19.95
Int. Diode and Thyristor Index Data & Subsitutions	BM-4578	$34.95

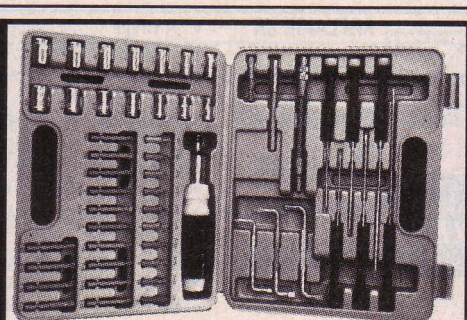


JAYCAR WHOLESALE (02) 743-5222

51 Piece Ratchet Screwdriver Socket Set

Brand new unit for 1995. Its now in a better plastic case, and has new tools including 6 fine long handled screwdrivers, flexible drive shaft and three right angle screwdrivers. This saves you $4.00. Here's what you get:- •1 x ratchet driver •1 x flexible drive shaft •4" extension bar •1/4" drive socket adaptor •3 slotted bits 5/32", 3/16", 1/4" •3 Phillips bits No 1, 2, 3 •8 Hex bits 1/16" (1.5mm), 5/64"(2.0mm), 3/32"(2.5mm), 1/8"(3.0mm), 5/32"(4.0mm), 3/16"(5.0mm), 7/32"(5.5mm), 1/4"(6.0mm) •2 square recess bits - P1, P2 •8 Torx bits T10, T15, T20, T25, T27, T30, T40, T45 •7 metric sockets 6mm, 7mm, 8mm, 9mm, 10mm, 11mm, 12mm •7 imperial sockets 3/16", 1/4", 5/16", 11/32", 3/8", 7/16", 1/2" •3 x right angled screwdrivers - small, medium, large, all housed in a tough durable plastic carry case with handle.

Cat. TD-2002 **JUNE ONLY $25** WAS $31.95



FREECALL FOR PHONE ORDERS 008 022 888

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10"	Polycone	160RMS	50LT	32LT	CW-2137	$109.50
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See 1995 catalogue page 47

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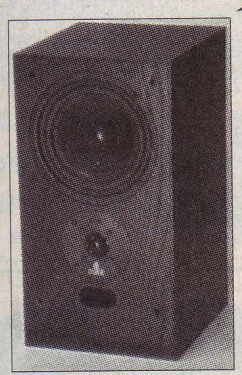

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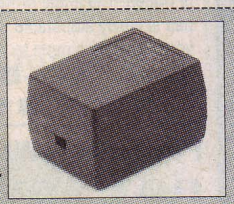

NEW

This case is new, but contains components which were removed. It consists of two halves of hard and high impact plastic held together by 4 self tapping screws. The box measures 88L x 68W x 55Dmm. In the middle of each lid is a small rectangular hole measuring 10 x 7mm. It is ideal for an in-line power supply or some sort of interface. It is well made and quite rigid. It would also make a cheap general purpose small enclosure. A redundant manufacturers identification panel appears on one side of the case. Even a low cost jiffy case of similar size would cost about $3.00. This box is better quality at half the price.

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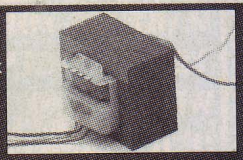

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CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.

Emergency lighting circuit has charger

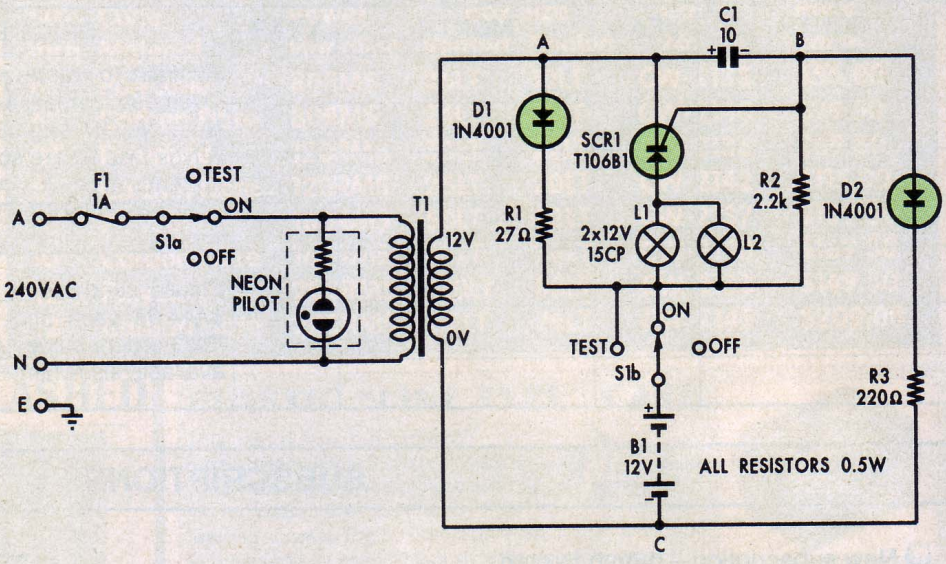
An emergency lighting unit is very useful when a power failure occurs. This circuit senses blackout and immediately turns on a standby light. It consists of a standby power source (12V storage battery), a set of lights (eg, automobile bulbs) and a switching device.

When in use, this unit is plugged into a power outlet. If there is power present, the circuit detects this and keeps the switching device in standby, so that the light bulbs are off. In the event of power failure, the circuit automatically triggers the switching device which connects the bulbs to the storage battery.

In this circuit switch S1 is a 2-pole, 3-position toggle with test, on or off modes. The normal setting is on and this connects 240VAC to transformer T1. During positive half cycles of the AC supply, C1 is charged via D2 and R3. This causes the cathode of SCR1 to be more positive than its gate and anode and so the SCR remains off.

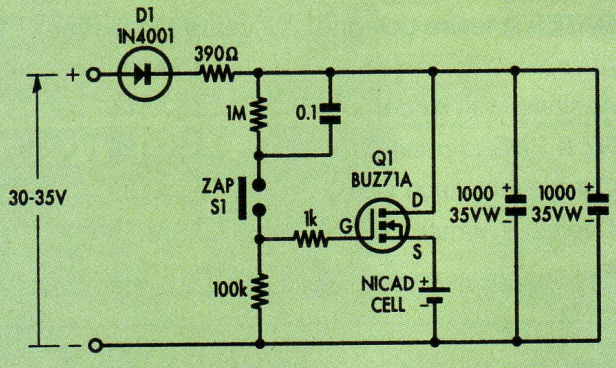
D1 and R1 provide trickle charging for the battery. If the AC power is suddenly interrupted, current flows from the battery and bulbs via SCR1 which has its gate current provided by R2. The return path to the battery is via the transformer secondary.

R. Sestoso,
Merrylands, NSW. ($30)



Low cost nicad zapper

To obtain a low cost nicad zapper, the circuit published in the August 1994 issue can be adapted to any DC supply which can deliver 30-35V DC. In essence, this version omits the step-up inverter and uses the direct output of a supply to charge the two 1000µF capacitors. The capacitor charge is then dumped through the nicad cell via Mosfet Q1 each time switch S1 is closed.



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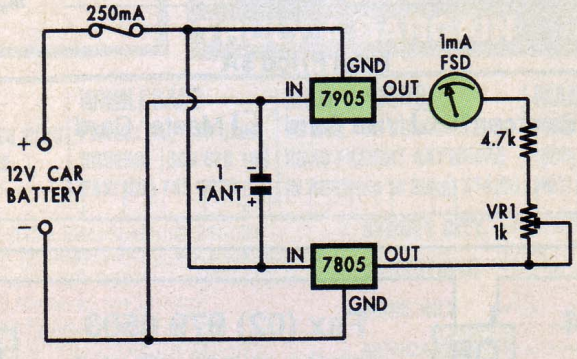
Expanded scale voltmeter for cars

This unusual circuit provides an expanded scale voltmeter which is intended for use in cars. It reads over the range from 10-15V.

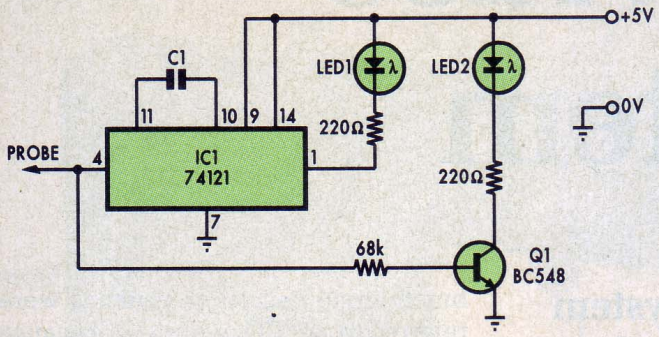
The circuit uses two 3-terminal 5V regulators to effectively subtract 10V from the input supply which is nominally 12V (ie, the car battery voltage). While the circuit configuration looks unusual, both 3-terminal regulators work in the conventional way and produce 5V between their output and GND terminals. Each 3-terminal regulator is fed with the full input voltage. Hence the 7905 regulator's output will be 5V below the positive input rail and the 7805's output will be 5V above the negative input rail. The two regulator outputs will have a voltage between them which is 10V less than the input voltage.



A 1mA FSD meter may be connected across the regulator outputs as shown, in series with a 4.7kΩ resistor and a 1kΩ trimpot for calibration.

Phil McKay,
Silvan, Vic. ($30)

Simple probe detects logic levels & pulse trains



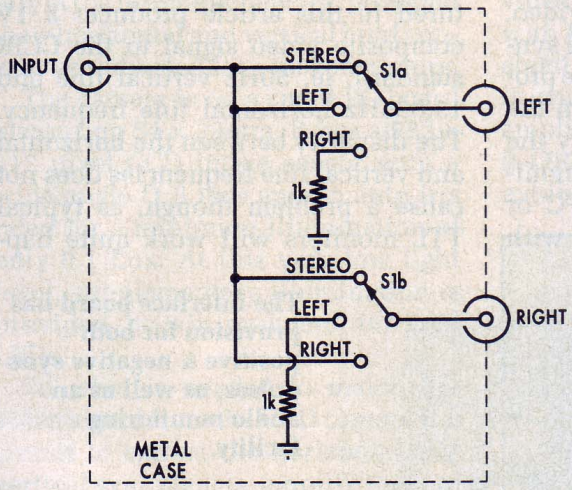
This simple logic probe can detect low, high and floating logic levels, single shot pulses and pulse trains. When the probe is connected to logic 0, the transistor is off and therefore LED 2 does not light. However, if the input level is floating, a small current from IC1 will keep the transistor on slightly, causing LED 2 to glow dimly.

LED 1 is only on when the monostable is triggered, which occurs with a logic 1 to 0 transition at the input. So for a single pulse, there is only one transition and therefore, one flash from LED 1. A pulse train will continually re-trigger the monostable and so the LED will keep flashing. Note that high frequency pulse trains cause LED 1 to glow brighter than low frequency pulse trains.

The 68kΩ resistor may need to be slightly adjusted so that a floating input level will cause LED 2 to glow dimly. C1 must also be large enough to produce a flash from LED 1 with each pulse.

A. Chin,
Heidelberg, Vic. ($30)

Stereo signal switcher for testing



When testing stereo equipment, it is necessary to switch the audio generator to drive either or both channels. In the former case, the undriven channel input should be loaded with a low value resistor to simulate the internal impedance of the signal source. If the undriven channel input is not loaded in this way, the resultant crosstalk and signal-to-noise ratio figures can be degraded.

The solution to this problem is to use a double-pole 3-position rotary switch (S1), wired as shown in the accompanying circuit. When either the left or right channel is selected by S1, the undriven channel input is loaded with a 1kΩ resistor which is connected to ground. Note that the switch should be mounted in a metal box for shielding, while RCA sockets can be used for the input and output connections.

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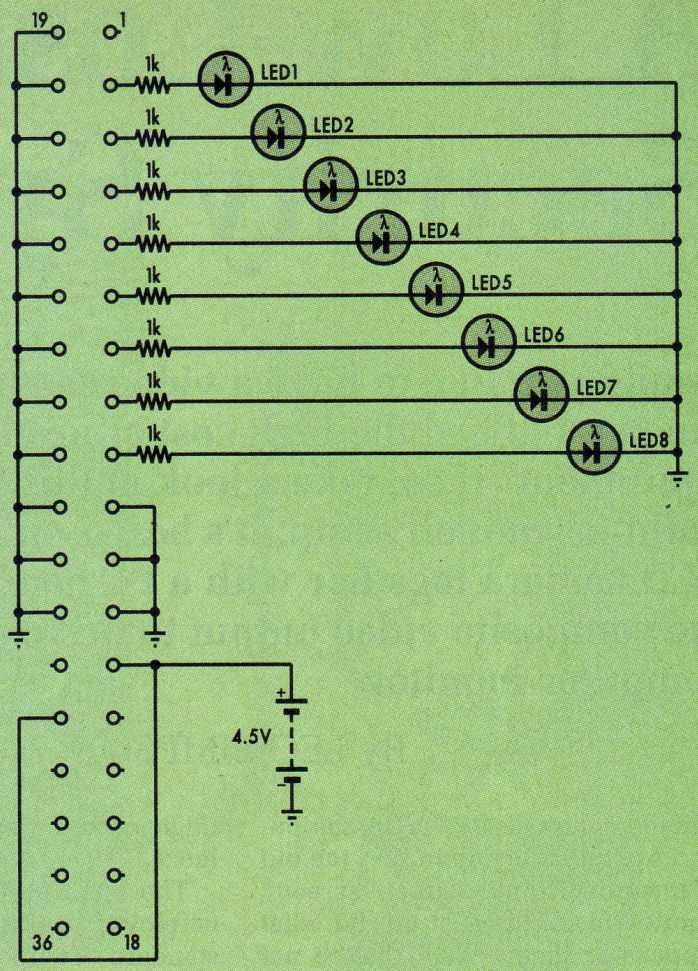


Dummy printer for testing parallel ports on a PC

This simple circuit acts as an IBM-compatible printer except that it takes only seconds to print a file and there is no waste of paper or ribbon when doing tests. It is very useful for testing parallel printer ports or to let you use a print capture utility (eg, some fax programs can actually capture the printing output and convert it into a fax file) without waiting for the actual printout.

In essence, the circuit provides loading to eight lines of a Centronics printer port and maintains pins 13 & 32 at +4.5V. Pins 19-30 and 10-12 are grounded. The LEDs are included to show the printing status. When they are flashing, it means that the printing process is taking place.

The complete circuit was built and tested and works with any printer emulation, even from Windows.

J. Akkad,
Pascoe Vale South, Vic. ($30)

A Low-Cost Video Security System

Would you like to have a video security system but can't afford the high cost of professional equipment? If so, take a look at this low-cost build-it-yourself setup. It's based on a compact CCD camera together with a PC board to convert the composite video output to drive a surplus computer monitor.

By LEO SIMPSON

In these days of super VGA computer monitors, it is rare to find the old TTL monochrome "green screen" monitors being used at all. So what happens to them? Well, they're not much use as boat anchors but they do have potential for use in a small closed circuit television security system such as the one presented here.

The video security system described here consists of a small CCD camera, a monochrome monitor and a small PC board. The board takes the composite video signal from the camera and separates the horizontal and vertical sync signals to drive the monitor. The board also amplifies the video signal by a factor of about two to three.

Finally, there is a small audio amplifier on the board to allow a microphone to monitor any sounds that might occur in the area under surveillance.

The high resolution video camera employed in this project produces a standard "composite" 1V p-p signal that combines video, vertical and horizontal synchronisation. This output can be connected to a black & white or colour video monitor, a television receiver which has a direct video input, or the video input on a VCR which can then drive a TV set.

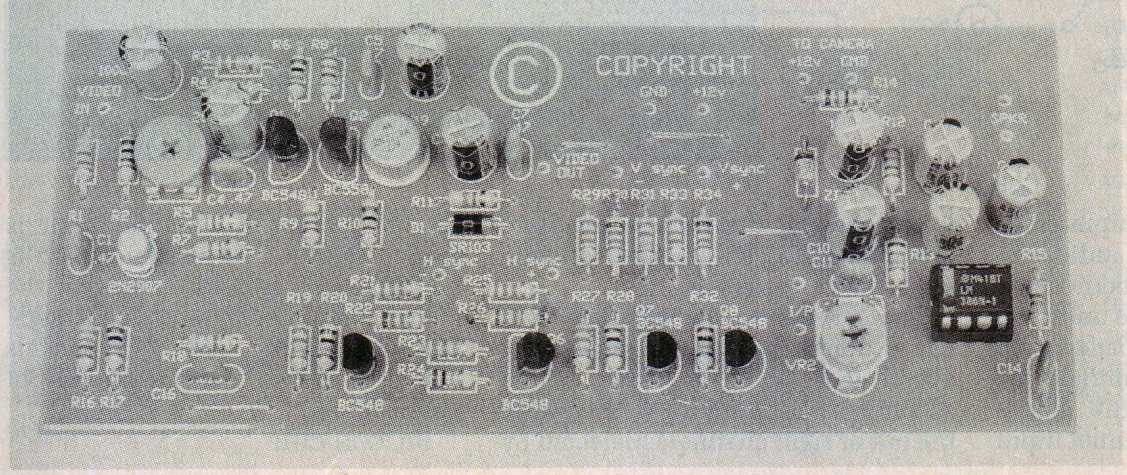
Computer monitors, on the other hand, usually require separate video, intensity, horizontal and vertical synchronisation signals and these are produced via a 9-pin D-socket from the computer's video drive card. By the way, these monochrome video monitors, usually used with IBM PC or compatible computers but also with much larger computer systems, were referred to as "TTL monitors" because their drive signals came from 5V logic circuitry (eg, TTL).

Fig.1 shows the 9-pin D-socket of a typical TTL monitor and the signals present at each pin. Note that for our application, the intensity modulation signal at pin 6 is not required.

Typical TTL monitors as used by IBM computers had a vertical horizontal line frequency of 60Hz, a horizontal line frequency of 18,432Hz and a video bandwidth of 15MHz or more – far superior to a typical monitor intended for use with VCRs and TV signals.

Now while the text display typically used on computer monitors normally involved a 5V signal, the video signal required in our application is analog in nature (ie, it is a picture with a wide range of contrast rather than the on-off format of text displays). Hence, the video signal level required by these monitors is around 3-4V p-p.

By contrast, the CCD camera featured in this article produces a 1V composite video signal to the CCIR standard; ie, 50Hz vertical line and 15,625Hz horizontal line frequency. The disparity between the horizontal and vertical line frequencies does not cause a problem though, as typical TTL monitors will work quite hap-



The interface board has provision for both positive & negative sync pulses, as well as an audio monitoring facility.

Above: our photographer, Stuart Bryce, has been captured by the CCD camera as this photo was taken. The CCD camera functions well even in very low light conditions.

pily at the lower frequencies, provided their horizontal and vertical hold controls are adjusted for a locked picture.

The camera is on a small PC board measuring 54 x 38mm. It has a 582 x 512 pixel CCD image sensor with a wide angle f1.8 lens and an auto iris rated for a minimum illumination of only 0.1 Lux. At this very low light level, supplementary illumination is provided by six on-board infrared LEDs.

So what is needed to match the video signal from the CCD camera is a circuit to extract the horizontal and vertical sync signals, amplify them to the correct level and boost the video signal to about 4V p-p. The circuit is shown in Fig.2.

How it works

Incoming video is applied via trimpot VR1 and the paralleled 100Ω resistor R2. VR1 is used to adjust the video input level while R2 in parallel with VR1 sets the input impedance to about 70 ohms. From there, the signal is coupled to the input of the first amplifier stage via C4 and C3. C4 is a 0.47µF monolithic capacitor which exhibits low inductance; it was included to compensate for the inductance of the 100µF electrolytic capacitor C3. This inductance could otherwise reduce the amplitude of the higher video frequencies.

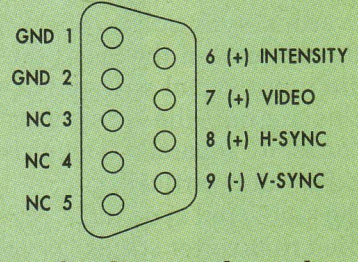


Fig.1 this diagram shows the 9-pin D-socket for a typical TTL monitor & the signals present at each pin. Note that for our application, the intensity modulation signal at pin 6 is not required.

The first common emitter amplifier stage, based on NPN transistor Q1, has a gain of about 2, determined mainly by the ratio of R6 to R7. The output from this stage is directly coupled to a second common emitter amplifier stage based on PNP transistor Q2. This stage also has a gain of approximately 2, mainly determined by the ratio of R9 to R8.

Q2 is directly coupled the base of NPN transistor Q3 which functions as an emitter follower to give the amplifier a low output impedance. It is capable of providing an output swing of about 4V p-p.

The output of Q3 is AC coupled by C7 and C8 to a DC restoration stage consisting of resistor R11 and diode D1. D1 clamps the negative transition of the video signal to ground (actually to about -0.5V below 0V). D1 is a

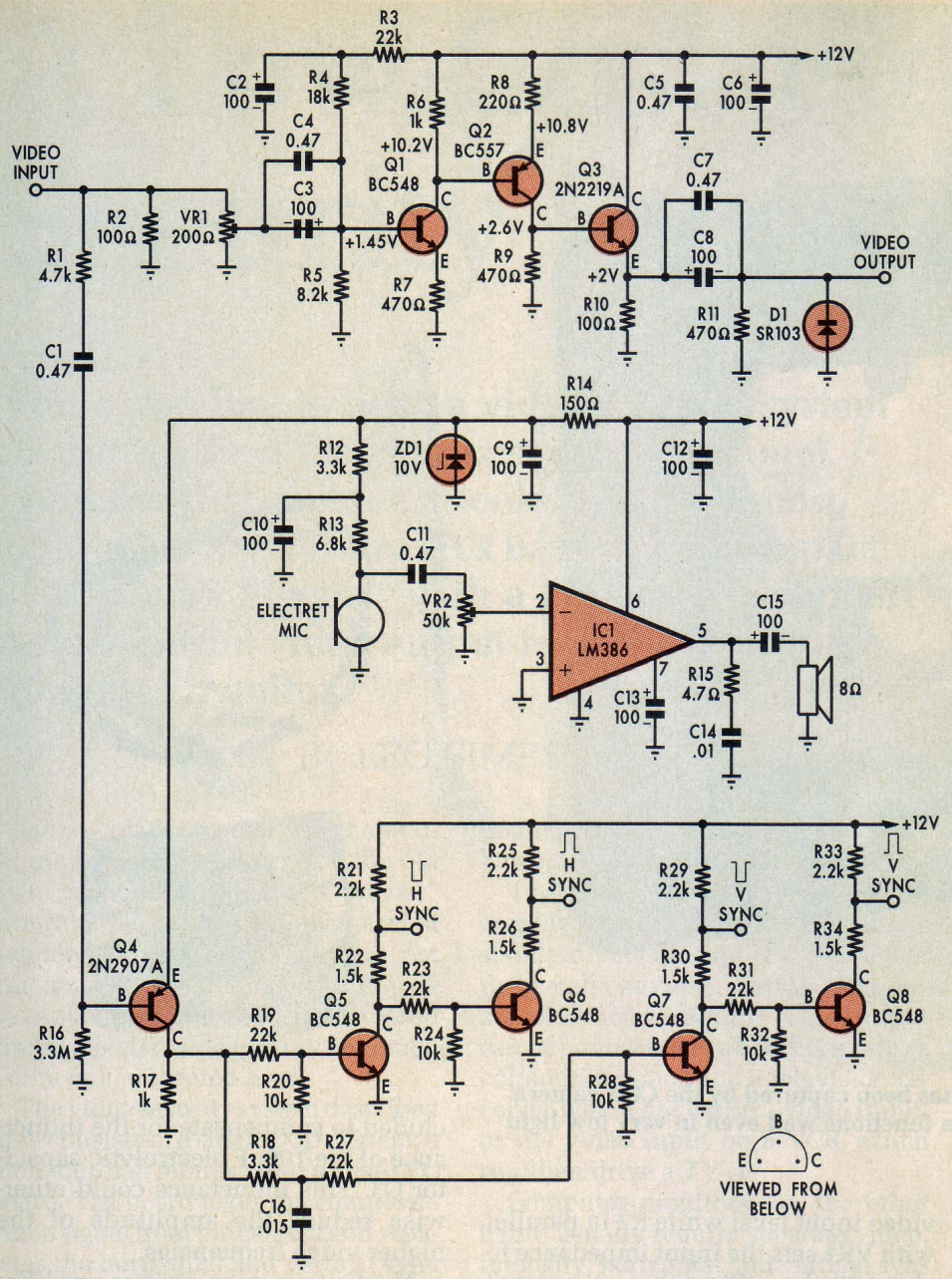


Fig.2: the circuit takes the incoming video & amplifies it by a factor of four using Q1, Q2 & Q3. Q4 extracts the sync signals (ie, sync separator), while Q5 & Q6 provide positive & negative sync pulses. R18 & C16 function as a low-pass filter to extract the vertical sync pulses & these are fed to Q7 & Q8 to provide both sync polarities. IC1 provides an audio monitor facility.

Schottky diode which is very fast, a requirement for video signals.

This means that the video signal extends from zero volts up to a maximum positive value around 4V, assuming a 1V p-p input signal.

Transistor Q4 is employed as a sync separator. It is biased almost to cutoff by the 3.3MΩ resistor R16. Because of this and signal coupling via 0.47µF capacitor C1, Q4 conducts only on the negative peaks of the incoming composite video signal. This is exactly what we want, since the negative peaks correspond to the horizontal and vertical sync pulses. So the signal at the collector of the Q4 is the composite input signal stripped of video and leaving only the sync pulses. Now we have to separate the horizontal sync from the vertical sync.

The recovered sync pulses are then applied to inverter stages Q5 and Q6. These produce both positive and negative horizontal sync pulses. This was done to cater for a range of monitors, some of which require positive sync pulses and others negative pulses.

The vertical sync pulses are obtained by feeding the "mixed" sync from the emitter of Q4 to a low-pass filter comprising 3.3kΩ resistor R18 and .015µF capacitor C16. The resulting low frequency signal is squared up by Q7 to give a negative-going sync pulse and inverted by Q8 to give a positive-going sync pulse.

The audio amplifier is based on an LM386 IC. R12 and R13 provide the bias voltage needed for an electret microphone while C10 bypasses the electret bias line. The electret's audio signal is coupled via 0.47µF capacitor C11 to volume control VR2 then to IC1 which has sufficient gain to drive the 8Ω loudspeaker.

Construction

Assembling the PC board is a straightforward process which will probably take most people under an hour. The board is supplied with a component overlay on top and has a green solder mask on the copper side to make soldering clean and easy.

The parts layout is shown in Fig.3. We suggest you install all the resistors first, followed by the diodes and small capacitors. It is a good idea to check each resistor value with a digital multimeter before soldering it in.

Following the small components, the electrolytic capacitors can be installed and then the transistors and trimpots. Make sure that each electrolytic and transistor is installed with the correct polarity and ensure that you don't get the transistors swapped around – PNP transistors don't work in place of NPN types and vice versa!

Finally, you can install the LM386 IC and the board is complete.

Monitor installation

The next step is to install the video conversion board into a small surplus computer monitor which is supplied as part of the kit for this project. The monitor is a secondhand 12V unit with a small screen. Probably this monitor would have been used as a terminal in a bank or insurance company.

First, remove the diecast metal case of the monitor which is done by undoing four screws at the rear and then sliding it off. The board is installed quite simply by attaching it to the vertical panel opposite the EHT transformer. The side panels look like cardboard but are made of a Bakelised insulating material such as Presspahn. Drill a couple of holes through this

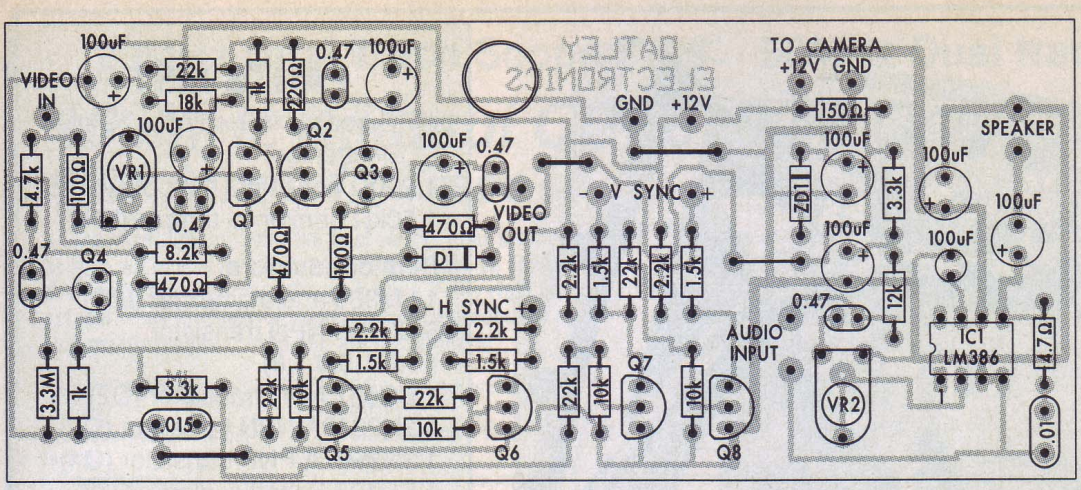


Fig.3: install the parts on the interface PC board as shown here. Take care to ensure that all polarised parts are correctly oriented.

side panel so that the PC board can be attached with two diagonal screws and nuts. However, before doing that you have to make the various interconnections.

The practical way to do this is to remove the edge connector at the rear of the monitor's PC board. This duplicates the connections made to the 9-pin D socket at the rear of the chassis and has the advantage that it is much easier to solder wires to than the D-socket itself.

You will now need to run hook-up wire of different colours between the video board and the 10-pin edge connector. If we arbitrarily assign the pin numbers from left to right, the connections are as follows: pin 2, vertical sync; pin 3, video; pin 4, +12V; pin 5, horizontal sync and pin 10, GND.

The input from the electret microphone insert should be run in audio shielded cable while the speaker connections can be in normal hook-up wire. Lace the cables together for a neat job and make sure that there is no chance of them coming into contact with the high voltage supply for the monitor.

Camera mounting

To run the camera, interface board and monitor, you will need a 12V DC supply that can provide a little over 1 amp. This will need to be reasonably well filtered and regulated otherwise hum bars are likely to be present in the picture.

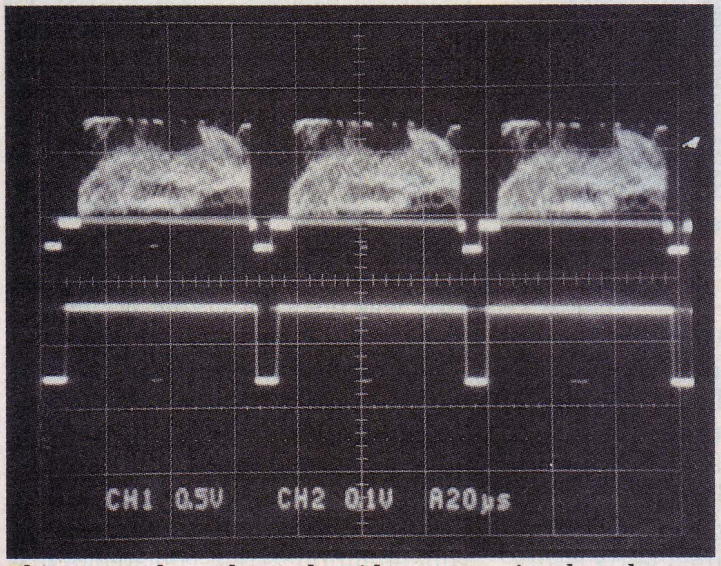
The CCD camera module will need to be mounted in a small plastic case so that it is protected and reasonably unobtrusive. In fact, you could mount it in plastic box with a dark tinted perspex window to make it look innocuous. You should be able to run the video output cable for a few metres without noticeable picture degradation.

When all the equipment is connected, you will need to adjust the vertical and horizontal hold controls for a locked picture and then adjust the brightness control for best picture quality.

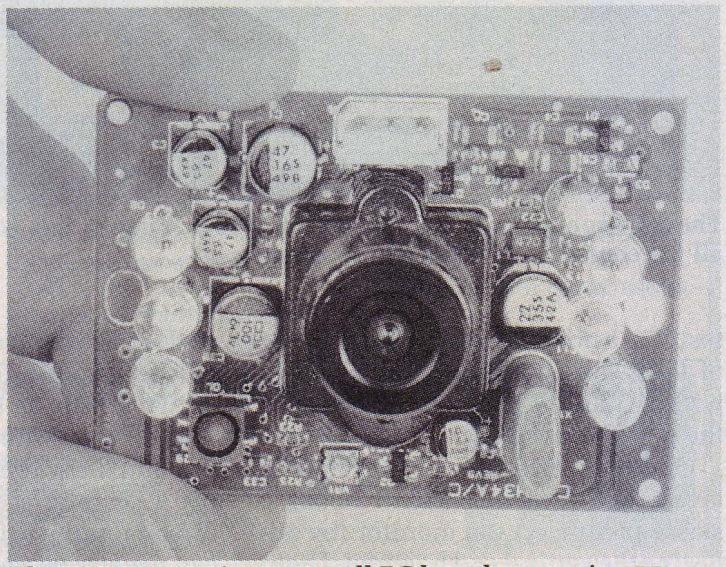
Other TTL monitors

While a small monitor is provided as part of this project kit, you may want to use a larger screen TTL monitor and this will probably present some problems of incompatibility. As it stands, the video interface board will probably not work well with standard TTL monitors and there are a number of reasons for this. First and foremost, the vertical and horizontal sync outputs are not directly compatible with the TTL inputs on many monitors because they do not swing between 0V and 5V. This can be achieved however, by a simple modification.

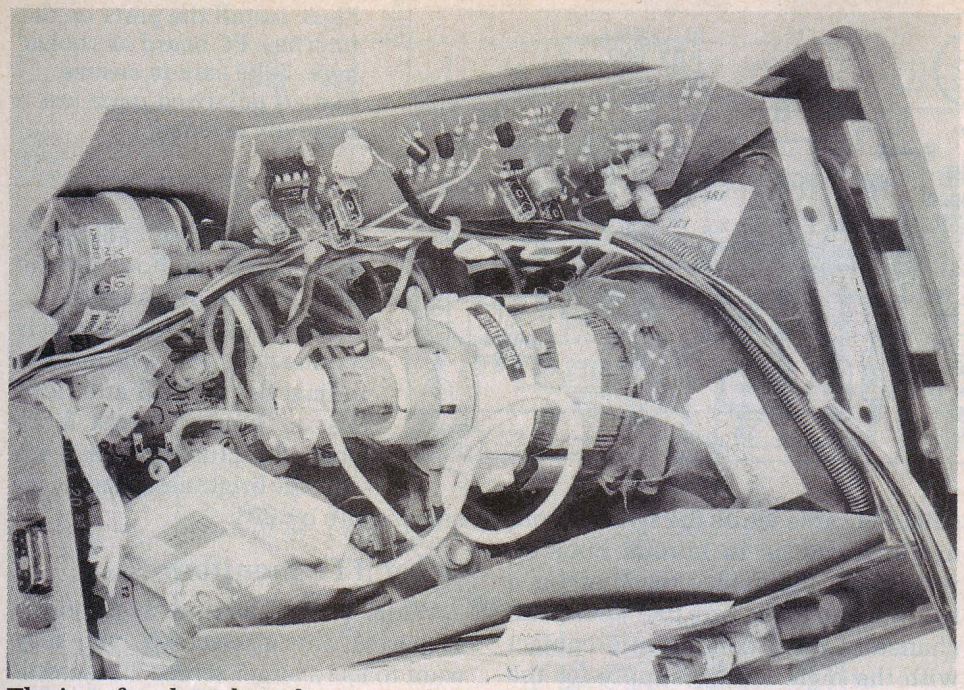
To convert all sync outputs to TTL levels, short out 1.5kΩ resistors R22, R26, R30 & R34, then connect a 2.2kΩ resistor across each of the sync transistors Q5, Q6, Q7 & Q8. This will



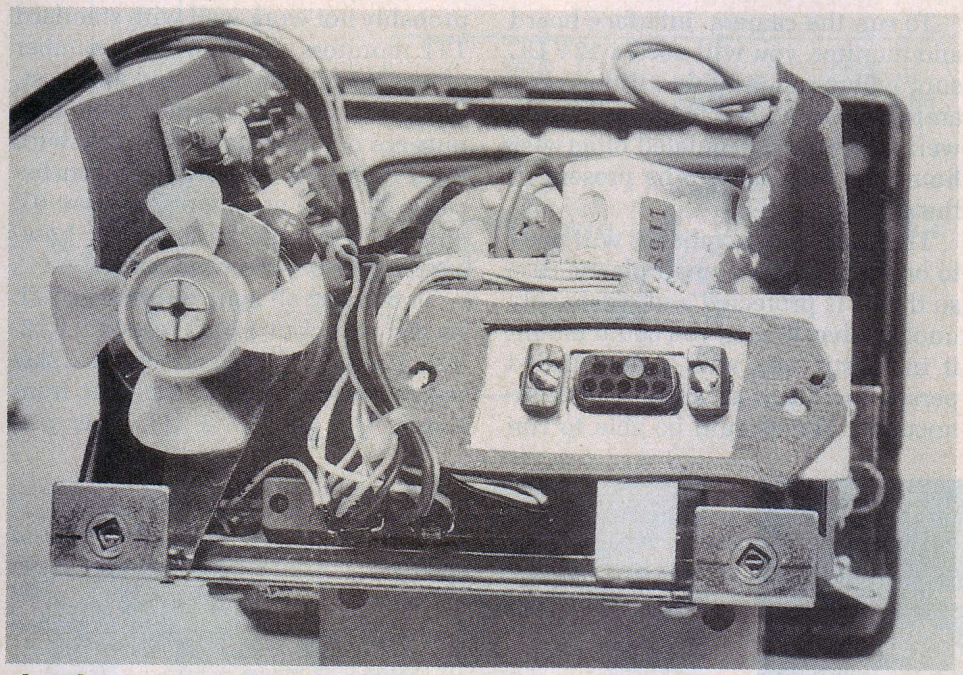
This scope photo shows the video output signal on the top trace (CH2) & the negative horizontal sync signal from Q5 on the lower trace (CH1). Note that the video signal is about 2V peak-peak & this can be increased as required by adjusting VR1. The sync pulses are close to 5V peak-peak & are spaced 64µs apart, exactly as they should be.



The CCD camera is on a small PC board measuring 54 x 38mm. It has a 582 x 512 pixel CCD image sensor with a wide-angle f1.8 lens & an auto iris rated for a minimum illumination of only 0.1 Lux. At this very low light level, supplementary illumination is provided by six on-board infrared LEDs (three to either side of the lens).



The interface board can be mounted along one side of the video monitor, as shown here. Make sure that it is properly secured.



The edge connector is just behind the D-socket panel. It is convenient to make all the connections to the edge connector.

PARTS LIST

1 PC board, 133 x 57mm (Oatley Electronics)
1 200Ω horizontal trimpot (VR1)
1 50kΩ horizontal trimpot (VR2)

Semiconductors

1 LM386 audio amplifier (IC1)
5 BC548 NPN transistor (Q1,5,6,7,8)
1 BC557 NPN transistor (Q2)
1 2N2219A NPN transistor (Q3)
1 2N2907A PNP transistor (Q4)
1 SR103 Schottky diode (D1)

Capacitors

9 100µF 25VW PC electrolytic
5 0.47µF monolithic ceramic
1 .015µF 25V ceramic
1 .01µF 25V ceramic

Resistors (0.25W, 1%)

1 3.3MΩ	4 2.2kΩ
5 22kΩ	4 1.5kΩ
1 18kΩ	2 1kΩ
4 10kΩ	3 470Ω
1 8.2kΩ	1 220Ω
1 6.8kΩ	1 150Ω
1 4.7kΩ	2 100Ω
2 3.3kΩ	1 4.7Ω

Where to get the kit

The three components of this project are the CCD camera module, video interface board kit and small video monitor. This is available as a package deal for $215 from Oatley Electronics, PO Box 89, Oatley, NSW 2223. Phone (02) 579 4985 or fax (02) 570 7910.

result in a nominal sync voltage swing of 0-6V but this will be reduced to within TTL limits by the loading of the monitor's inputs.

Once you have the correct TTL sync levels, you should be able to obtain a stable picture on the monitor (by adjusting the vertical and horizontal hold controls) but you will then probably find that the picture has just two shades, black and bright green. The reason for this is likely to be the TTL interface in the monitor itself. This will effectively convert the analog video from the external interface board to two levels, on and off.

Such a picture looks pretty hopeless and the way around it is to bypass the TTL interface chip and connect directly to the set's video input. This can usually be identified fairly easily because it will have a shielded cable running from the TTL chip to the picture or brightness control. If you connect the video signal directly to this shielded cable you should then be able to obtain a picture with the full range of contrast.

However, there is a further drawback to many TTL monitors and that is because of the picture phosphor. This was great for giving bright text displays but the phosphor usually has a long persistence (ie, takes a significant time for an image to fade). The result of this is that each time the camera image changes, it will blur the motion. This may not be a problem for some applications but we draw it to your attention so that you are not disappointed by the results.

On the other hand, the picture quality on the supplied small monitor is quite passable, especially so when the low price is considered. SC

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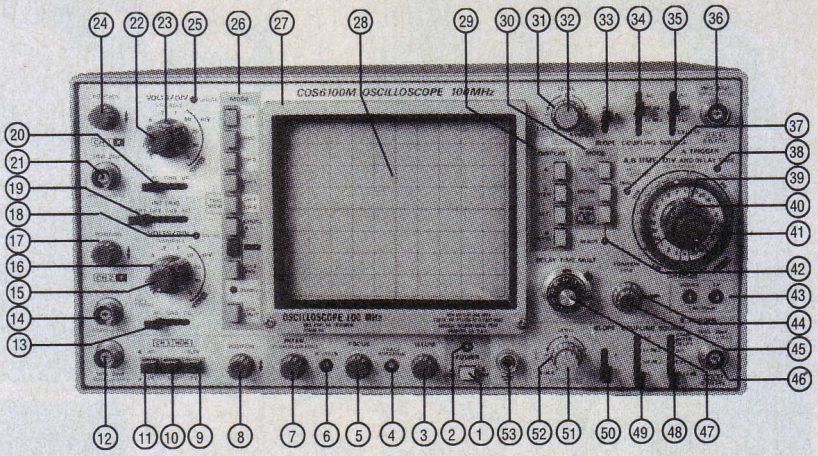

1. Power switch
2. LED
3. Graticule illumination switch
4. Trace rotation
5. Trace focus
6. Trace intensity for B sweep mode
7. Brightness control for spot/trace
8. Trace position
9/10/11. Select input coupling & sensitivity of CH3
12. Vertical input terminal for CH3
13. AC-GND-DC switch for selecting connection mode
14. Vertical input terminal for CH2
15/22. Fine adjustment of sensitivity
16/23. Select vertical axis sensitivity
17/24. Vertical positioning control
18/25/38. Uncal lamp
19. Internal trigger source CH1,CH2,CH3,ALT
20. AC-GND-DC switch for selecting connection mode
21. Vertical input terminal for CH1
26. Select vertical axis operation
27. Bezel
28. Blue filter
29. Display selects A & B sweep mode
30. Selects auto/norm/single sweep modes
31. Holdoff time adjustment
32/51. Trigger level adjustment
33/50. Triggering slope
34/49. Select coupling mode AC/HF REJ/LF REJ/DC
35. Select trigger signal source Int/Line/Ext/Ext÷10
36. Vertical input terminal for CH4
37. Trigger level LED
39. A time/div & delay time knob
40. B time/div knob
41. Variable adj of A sweep rate & x10 mag
42. Ready lamp
43. Calibration voltage terminals
44. Horizontal positioning of trace
45. Fine adjustment
46. Vertical input terminal for CH5
47. Delay time MULT switch
48. Selects between continuous & triggered delay
52. Trace separation adjustment
53. Ground terminal

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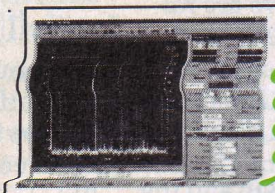
- Print out of graphs, data and settings



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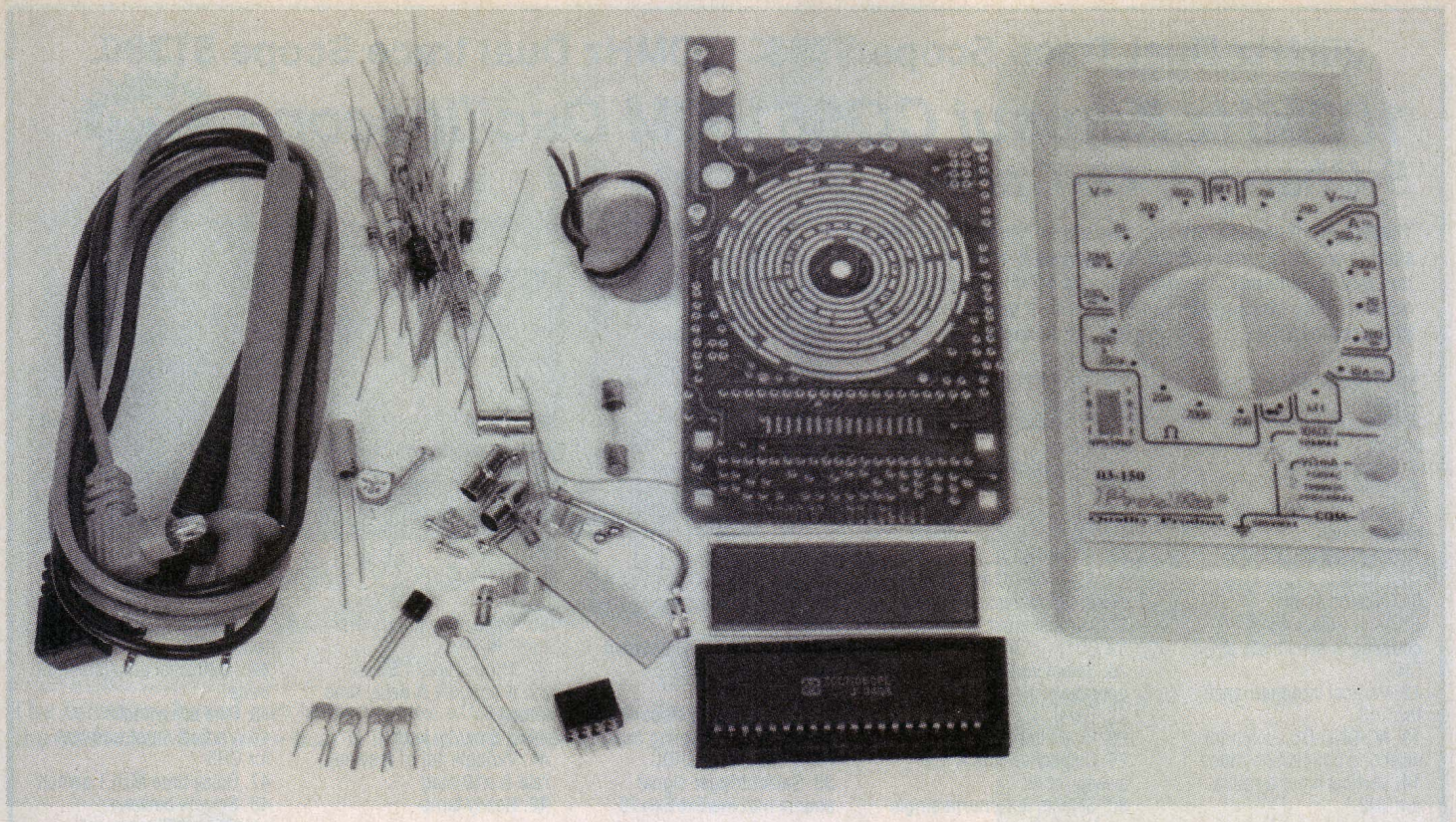


Build a digital multimeter for only $30

How cheap can you get? This little digital multimeter has no less than 19 ranges, including resistance, transistor gain measurement & a 10 amp DC range, all for just under thirty dollars. You buy it as a kit & put it together in an hour or two.

By LEO SIMPSON

Back in November 1989, we featured a low cost analog multimeter kit which cost just under $40. Now, with the inexorable march of technology, $30 will buy you a 3½-digit LCD multimeter with accuracy and resolution way beyond the reach of the old analog multimeter.

The meter measures 125 x 70 x 27mm thick and has a liquid crystal display with 12mm high digits. The display reads up to 1,999 and has auto polarity; ie, it has a minus sign to indicate when the reading is negative. Of the 19 separate ranges, five are for DC voltage (200mV, 2V, 20V, 200V and 1kV); two are for AC voltage (200V and 750V); five are for DC current (200mA, 2mA, 20mA, 200mA and 10 amps); five are for resistance (200Ω, 2kΩ, 20kΩ, 200kΩ and 2MΩ); and the two remaining ranges are for diode test (forward resistance at 1.5mA maximum) and transistor gain (h_{FE} with a base current of 10mA).

Rated accuracy is ±0.25% of reading ±2 digits on the 200mV DC range and ±0.5% of reading ±2 digits on the other DC voltage ranges. On the remaining ranges, accuracy typically is around ±1% of reading. As noted above, this is considerably better than could be expected from a typical analog multimeter.

The meter is powered by a standard 9V battery and rated battery life is 100 hours for carbon zinc and 200 hours for alkaline batteries.

Intersil ICL7106

As with many basic digital multimeters, this kit is based on the Intersil ICL7106 IC. This chip is an analog-to-digital converter combined with a liquid crystal display driver. Apart from the 7106 and the liquid crystal display, there are only two other semiconductors: one diode and one transistor. Everything else is inside the chip. The ICL7106 has an on-board

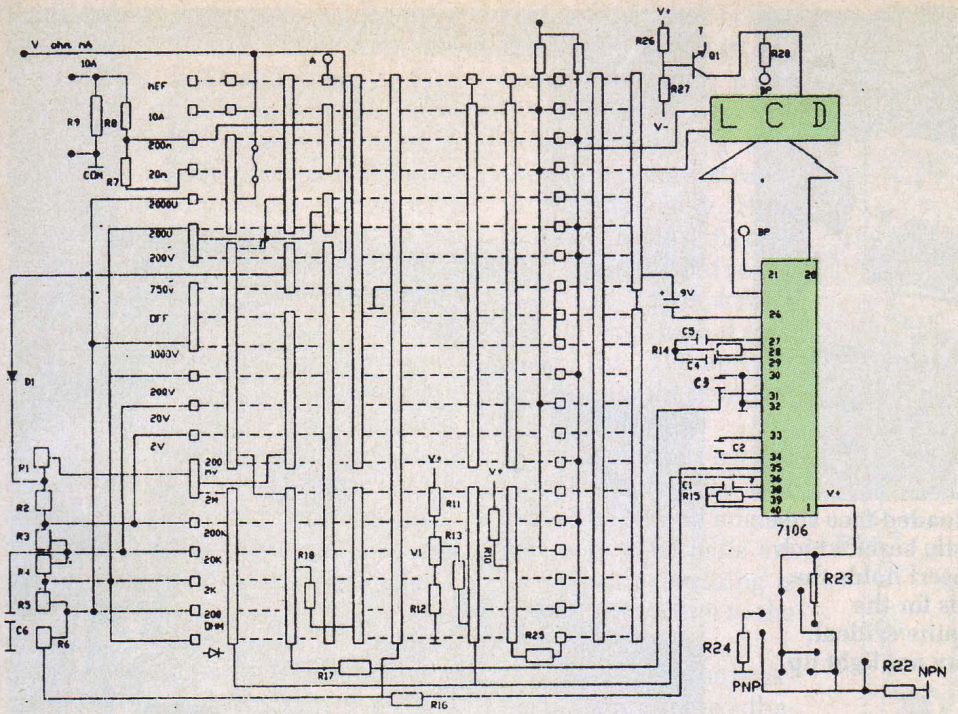


Fig.1: taken straight out of the instruction manual for the kit, the circuit of the multimeter doesn't show much. Most of it is devoted to the 20-position rotary range switch.

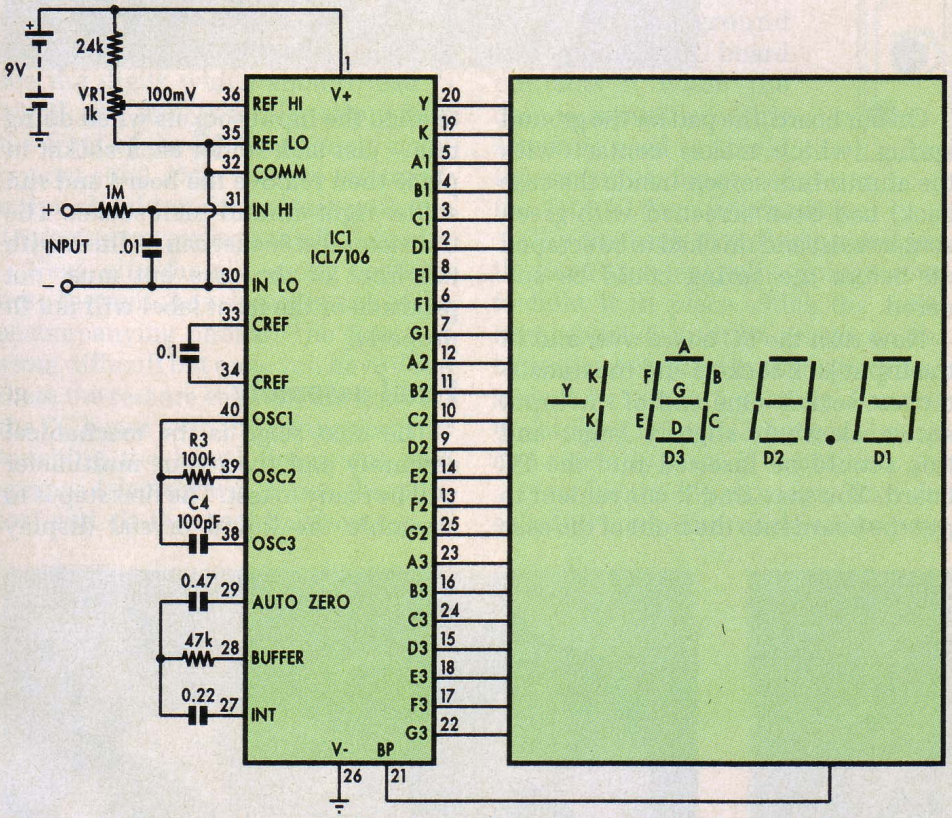
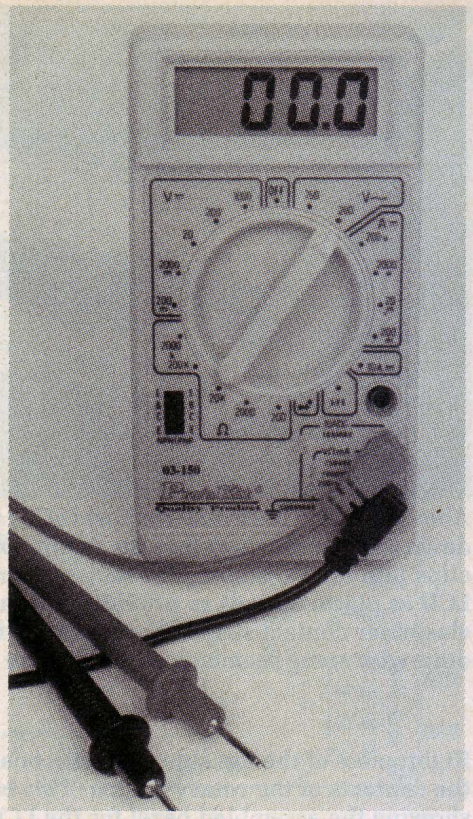


Fig.2: this diagram shows the functions of the 7106 digital voltmeter chip in more detail. Pins 2-25 provide the 7-segment drives for the display & the backplane signal which is common to all segments. Pins 30 & 31 are the actual pins for measuring the input voltage.

voltage reference which ensures its accuracy.

The circuit of the meter is depicted in Fig.1 and is taken straight out of the instruction manual for the kit. Actually, as a circuit it doesn't tell you much because most of it is devoted to the 20-position rotary range switch.

Fig.2 shows the functions of the 7106 digital voltmeter chip in more detail. Pins 2-25 provide the 7-segment drives for the display and the backplane signal which is common to all segments. Pins 38 to 40 are for the internal clock components. Pin 36 is the reference voltage input, pins 30 & 31 are the actual pins for measuring the input voltage. The other pins are for the auto-zero and dual slope integration components.

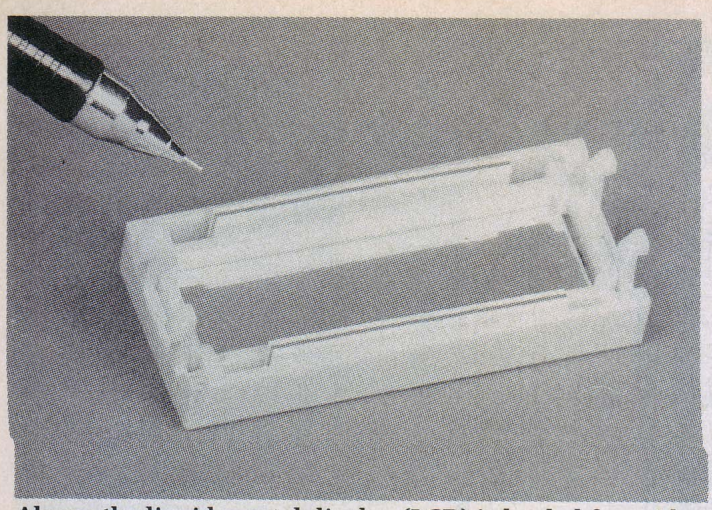


The finished multimeter is compact & convenient to use. It is small enough to fit into your shirt pocket.

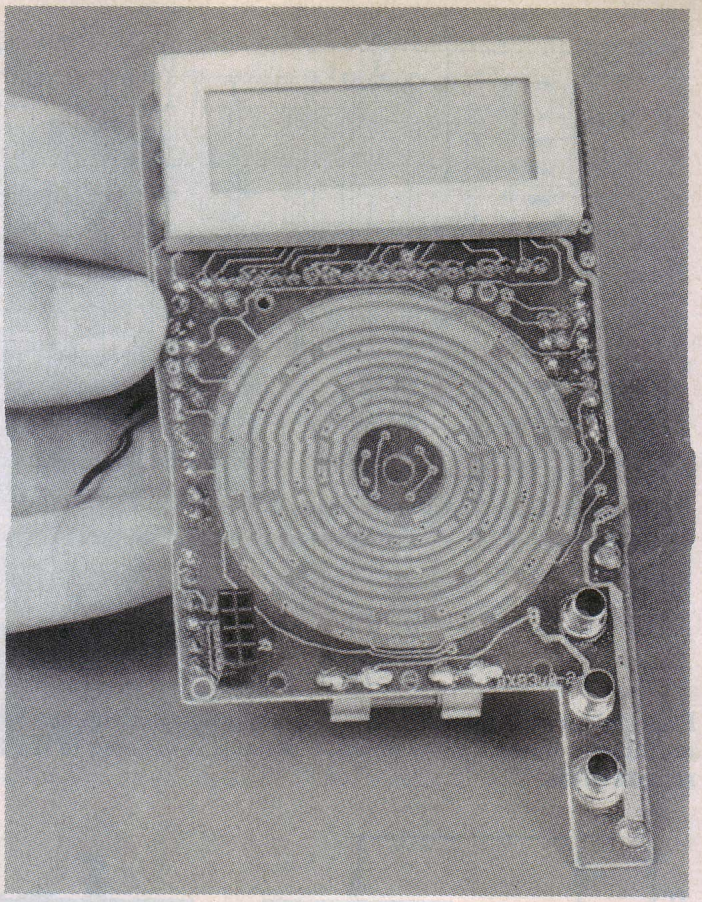
Construction

When you open the kit, you will find a bunch of parts in plastic bags. These will include meter test leads, battery and battery clip, all the tiny springs, ball bearings and screws to assemble the selector switch as well as the printed circuit board, the 7106 chip and the LCD display.

The first step is to assemble the components on the printed circuit board. These are in one plastic bag with the 7106 IC. Refer to Fig.3 for the position of the components. Most resistors have to be mounted vertically. The easiest way to do this is to bend one lead over so it lies parallel to the resistor body and spaced so it fits into the PC board holes. The resistor end should be about 2mm from the board. C6 will have to be mounted parallel to the board. R9, the 0.01Ω shunt resis-



Above: the liquid crystal display (LCD) is loaded face side down (mirror side up) into the yellow plastic bezel which clips into the PC board. The rectangular insert holds the LCD in place, as well as providing channels for the elastomer contact strips. Their placing is quite critical, otherwise some segments of the display may not light up.



Right: most of the top side of the PC board is taken up with the contacts of the rotary switch. This board is complete, showing the assembled bezel for the LCD, the three banana jack sockets and the transistor socket.

tor for the 10-amp range, is a piece of thick wire 60mm long with a 10mm bend at each end. It should be inserted so that the ends just come through the PC board, then soldered. Leave the 7106 till last and handle it carefully as it is a CMOS device.

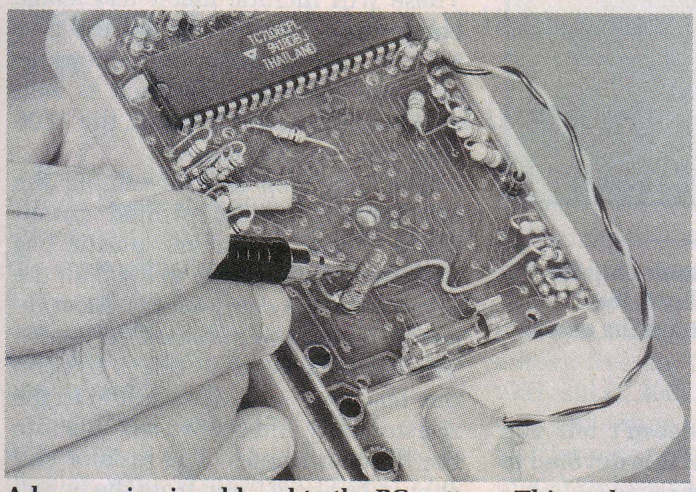
The battery clip and fuse clips, along with other components, are in a separate plastic bag and should now be fitted. When you position the fuse clips, be sure to place them so that the retaining lugs are at the outside, or else the fuse will not clip in.

On our board, the pad for the ground spring (which makes contact with the aluminium screen inside the case back) had been screened with green solder resist and this had to be scraped off before the spring could be soldered.

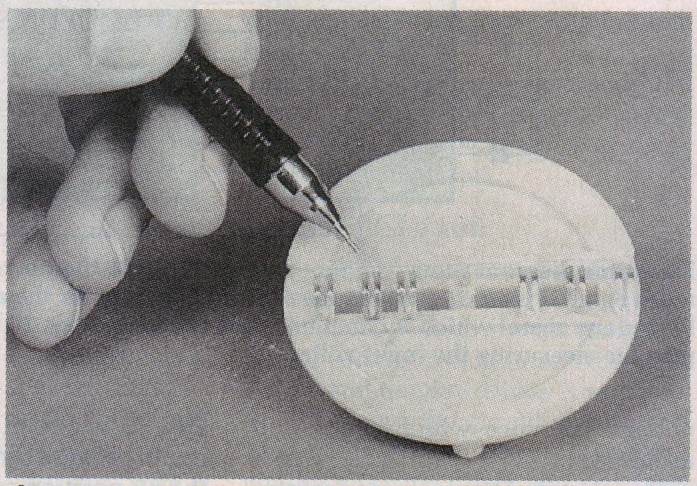
Now turn the PC board over and fit the input jack sockets and the transistor test socket. One end of the input socket sleeve is slightly larger and this should be inserted into the PC board. You may find it convenient to put the board into the front of the case to align the input sockets when doing this – just tack solder each socket in place then remove the board and run solder right around each socket. The transistor test socket can be flush with the front of the case but must not protrude or the front label will not fit properly.

Final assembly

The next stage is the mechanical assembly and then your multimeter will be ready to test. The first step is to assemble the liquid crystal display



A long spring is soldered to the PC pattern. This makes contact with the adhesive aluminium shield plate inside the back of the meter case.



The rotary switch is incorporated into the PC pattern, while six phosphor bronze spring contact wipers must be inserted into the back of the switch knob, as shown here.

(LCD) in its rectangular bezel. Remove the clear protective cover from the front of the LCD and place it face down (mirror side up) in the bezel frame. Drop the rectangular insert in to hold the LCD in place and slide the elastomeric connectors (incorrectly referred to as "rubber sponges" in the Asian-sourced instruction manual) into the top and bottom channels.

These connectors consist of a sandwich of two pieces of pink non-conductive rubber with a centre section of black rubber which has alternating (invisible) non-conductive and conductive strips. These unseen strips carry the signal from the LCD metallised terminals to the printed circuit board connector strips. The 16 metallised edge terminals on the glass of the LCD are virtually transparent but can just be seen if the panel is angled to the light to make them stand out.

This front assembly must now be mounted on the PC board. Take the assembly and hold it so that it will not come apart. Now look at the front in a good light and angle it so that you can see the digits which should read "-1888" and then carefully clip it into the front of the PC board (non- component side). Note that the elastomer strips should make contact with the 16 connector pads on the PC board.

Next, clip the six spring contacts onto the switch as shown in one of the accompanying photos. The first two seem difficult but once you have done them the rest are easy. Sit the knob on the PC board with the spring contacts touching the board. Insert the two springs (also shown in one the photos) and sit the steel balls on top of each spring. Now comes the tricky part. Lift the board and gently place the case front over the PC board making sure the knob comes cleanly through the hole. Hold the board against the case with one hand and screw the three small screws into the front (one at each end of the 7106 and the third under the centre of the fuse).

Check that the switch operates smoothly and shake the case to ensure that both steel balls are located. If everything is OK, set the switch to the OFF position.

Next, remove the backing paper from the adhesive aluminium screen and stick it centrally inside the back of the case. This done, check to make sure that the ground spring on the PC board contacts it when the case is assembled. This screen is used to shield the sensitive inputs of the 7106 IC from interference.

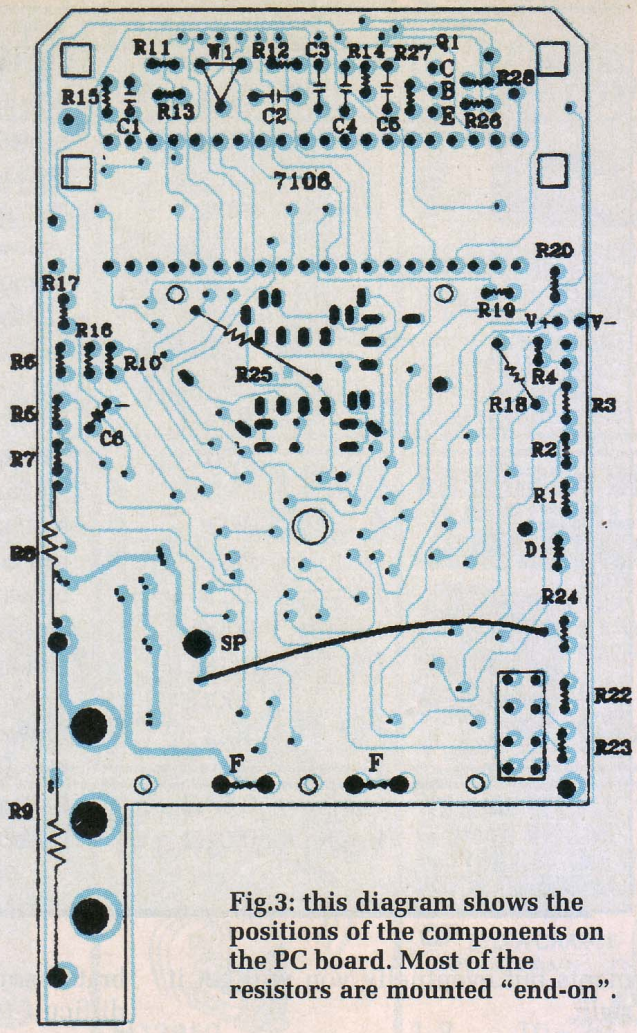
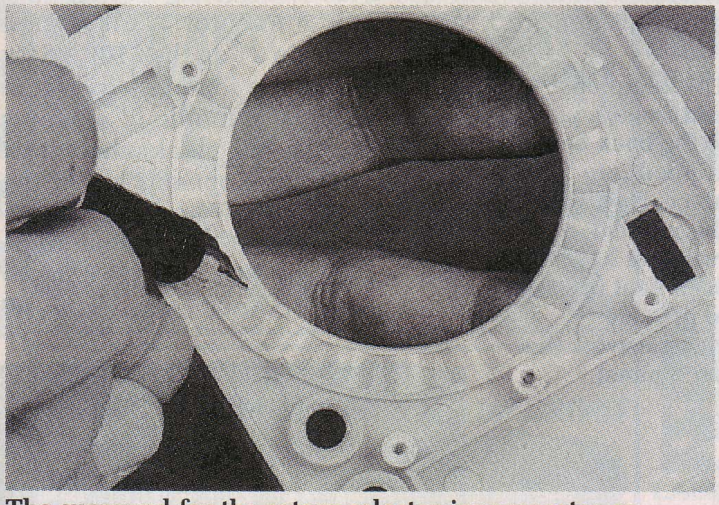


Fig.3: this diagram shows the positions of the components on the PC board. Most of the resistors are mounted "end-on".

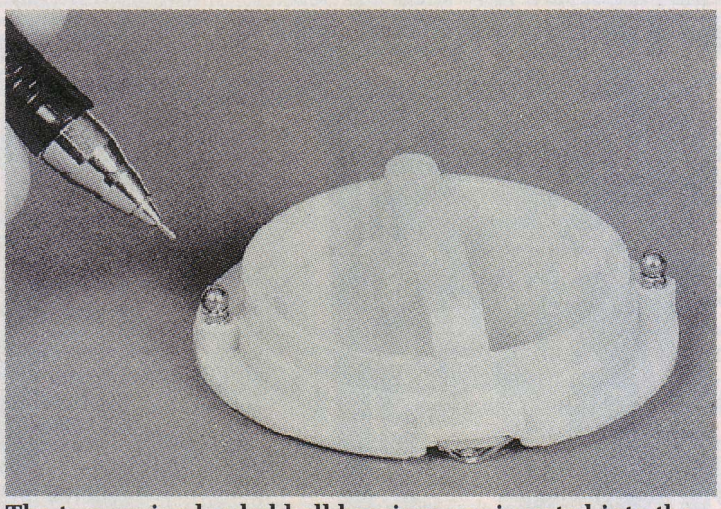
Clip the back in at the top and use the two 10mm long self-tapping screws to hold it in place. Stick the serial number label into the recess on the battery cover, plug in the battery and slide the cover into position. Remove the backing from the front panel decal and carefully place it in position.

Now for the big moment. Turn the selector knob one click either way from the OFF position and if you are greeted with 000 everything is probably OK.

In our case the a, b and f segments were missing from the first digit and the f segment from the second digit. We dismantled the unit, moved the top elastomer connector to the right from the rear, reassembled the unit and it worked fine. It may take one or two attempts to get all display seg-



The surround for the rotary selector incorporates an indexing plate to provide positive switch location. This is achieved with spring-loaded ball bearings.



The two spring loaded ball bearings are inserted into the rotary switch plate (one on either side) as shown in this photo.

RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (5%)	5-Band Code (0.1%, 0.5% or 1%)
❑	1	1MΩ	brown black green gold	Not applicable
❑	1	820kΩ	grey red yellow gold	Not applicable
❑	1	547kΩ	Not applicable	green yellow violet orange green
❑	1	470kΩ	yellow violet yellow gold	Not applicable
❑	1	330kΩ	orange orange yellow gold	Not applicable
❑	1	352kΩ	Not applicable	orange green red orange green
❑	2	220kΩ	red red yellow gold	Not applicable
❑	1	200kΩ	red black yellow gold	Not applicable
❑	1	100kΩ	brown black yellow gold	Not applicable
❑	1	90kΩ	Not applicable	white black black red green
❑	1	11.5kΩ	Not applicable	brown brown green red brown
❑	1	9kΩ	Not applicable	white black black brown green
❑	1	2kΩ	red black red gold	Not applicable
❑	1	1kΩ	brown black red gold	Not applicable
❑	1	900Ω	Not applicable	white black black black green
❑	1	380Ω	Not applicable	orange grey black black brown
❑	1	100Ω	brown black brown gold	Not applicable
❑	1	10Ω	brown black black gold	Not applicable
❑	1	9Ω	Not applicable	white black black silver green
❑	1	0.99Ω	Indicated on resistor	Indicated on resistor
❑	1	0.01Ω	No code; this is a metal bar	No code; this is a metal bar

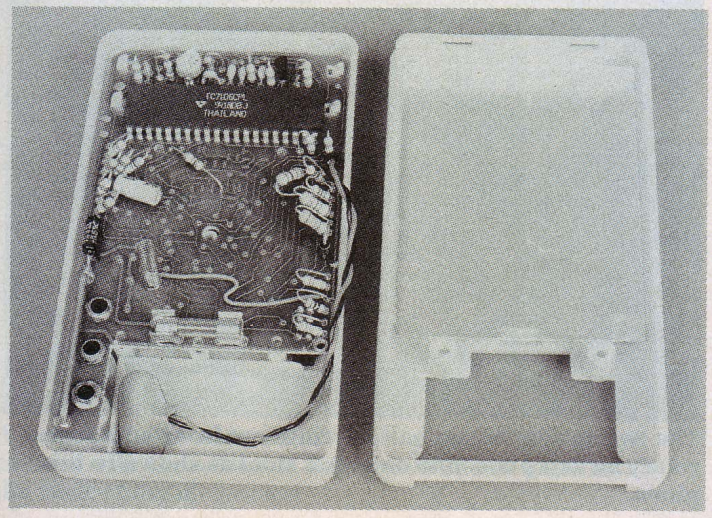
ments but eventually you will get it right.

Testing & calibration

Six 1% resistors, 1MΩ, 100kΩ, 10kΩ, 1kΩ, 100Ω and 24Ω, were supplied with the kit (from Altronics) to check the "Ohms" ranges. Our readings were 995kΩ, 99.1kΩ, 9.92kΩ, 992Ω, 99.2Ω and 24.2Ω which are all well within the specification of ±0.8% of reading ±2 digits. There are no calibration adjustments for the Ohms ranges, but if you have mixed up resistor values on the PC board it may show up here.

The voltage ranges have to be calibrated and this is probably the most difficult task for the hobbyist. If you have access to another multimeter, get a battery or a regulated power supply set to about 1.5 volts. Connect both meters and carefully adjust RV1 until the readings are the same. You will have to remove the back to gain access to this adjustment.

On the other hand, if you do not have access to another multimeter, there is a good alternative. Just go out and buy the cheapest silver oxide 1.5V button cell (as used in cameras, watches and calculators) you can find. You should be able to buy one for around $3.00. It will have an open circuit voltage of 1.55-1.56V which makes a good reference. Switch your new multimeter to the 2V DC range and check the voltage of the cell. If the reading is not between 1.55V and 1.56V, adjust RV1 until the meter reading is 1.555.



The completed multimeter, prior to the back being clipped into place. Note how the vertical resistors have been bent inwards to provide clearance for the back panel.

Troubleshooting

If the display is completely blank when you first turn on your finished multimeter, do not panic. It's probably because the backplane signal to the LCD is not getting through the elastomer connector. This signal comes from pin 21 on the 7106, so try repositioning the top elastomer connector. If, after a couple of attempts the display is still blank, check that the polarised components are in the correct way on the PC board.

Finally, check your soldered joints and check the values of all the components above the 7106 chip. SC

Where To Buy The Kit

The kit for this digital multimeter is available from Altronics and their dealers and from all Dick Smith Electronics stores.

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LOW COST TRANSISTER & MOSFET TESTER

This handy tester is designed to plug into a digital multimeter to provide accurate measurement of transistor beta, to values up to 50,000 or more. You can use it to test small signal, power & Darlingtons transistors &, as a bonus, it will check Mosfets.

SC ***May '95***

K10675 **$29.95**

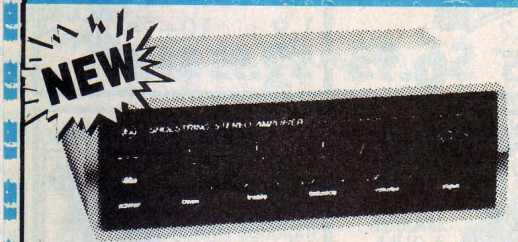
A PHOTOGRAPHIC TIMER FOR DARKROOMS

If you are looking for an accurate way to control film developing times, then take a look at this Photographic Timer. It will switch on mains-powered fluorescent ultraviolet tubes or incandescent lamps rated at up to 1200W for a preset time ranging from 1 - 450 seconds.

Silicon Chip April '95

K10665 **$64.95**

A BUDGET PRICED "SHOESTRING" STEREO AMP



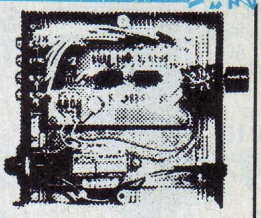
GREAT VALUE! IDEAL FOR SCHOOL PROJECT OR MULTIMEDIA.

K10650 **$99.95**

With a power rating of around 15 watts per channel and impressive noise and distortion performance, this new low cost amplifier is ideal for small hi-fi systems, "home theatre" installations, and a host of other applications. It uses readily available parts, offers a basic range of features, and is very easy to put together. Ideal for school. College or University project or built to work as a computer multimedia amplifier.

EA Dec'94

ECONOMY SURROUND SOUND DECODER



Perhaps your budget can't quite stretch to the cost of a full "bells and whistles" Dolby Pro-Logic surround sound decoder. Or alternatively, you might be one of those music lovers who doesn't like the idea of subjecting your favourite music to a lot of fancy digital processing. Either way, this really low cost Halfer-type analog decoder should appeal to you.

EA ***May '95*** K10670 **$59.95**

DIGITAL TRIGGER ADAPTOR FOR SCOPES

K10660 **$68.95**

With eight inputs (expandable to 24), this useful device will monitor almost any digital circuit and trigger your oscilloscope only when a preset combination of inputs is found. It also includes an adjustable triggering delay, so it can effectively convert your scope into a low cost logic analyser.

EA ***April '95***

3-SPOT LOW DISTORTION SINEWAVE OSCILLATOR

This sinewave oscillator is ideal for testing audio equipment & loudspeakers. It provides three switch-selectable spot frequencies at 100Hz, 1kHz & 10kHz, with levels up to 3V RMS & less than 0.004% distortion.

Silicon Chip Dec' 94

K10645 **$49.95**

BEGINNER'S VARIABLE DUAL-RAIL POWER SUPPLY

If you are just beginning in electronics, then you'll properly baulk at building a mains-operated power supply. This project uses a plugpack which means that you can make your own variable dual-rail power supply without worrying about mains wiring. ***Silicon Chip Oct '94***

Needs plug pack M19017.

K10635 ~~$59.95~~ **$39.95**

PLUG PACK

A plug in style power supply with fixed 16VAC output ideal for use with alarm control panels. Tinned ends for hard wiring to the panel. Australian safety standard AS3108

INPUT:	240VAC 50Hz
OUTPUT:	16VAC unregulated
CURRENT:	1500mA

NOW **$21.95**

M19017 ~~$25.95~~

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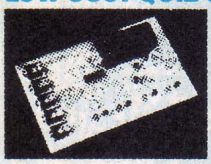
Protect your home form intruders with this up-to-the-minute burglar alarmsystem. Easy to build and cost less than equivalent commercial version. Features eight separate inputs, individual sector control, battery back-up, and self-test facility.

EA Jan'85

SPECIAL AT $99.00

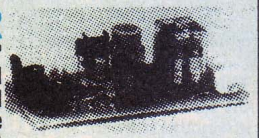
LOW COST QUIZ GAME ADJUDICATOR



Host your own game show in your lounge room with this great little kit. No more arguing about who was first to answer the question. The "Quizmaster" lights a LED and briefly sounds a buzzer to indicate which four players pressed the button first. If your looking for a judge who's not bias, prejudice or favourable to family members or friends this is the kit for you. ***Silicon Chip July '93.***

K10390 ~~$34.95~~ NOW $29.70

STEREO LOUD SPEAKER PROTECTOR



Dubbed the "protector" this small module will save your expensive loud speaker from damage due to an amplifier fault or destructive drive signals. It includes an excellent de-thump circuit and can be either built into an existing amplifier or housed in its own enclosures as a free standing unit.

E.A Oct '92.

K10360 ~~$29.95~~ NOW $25.45

UPGRADED DIGITAL CAPACITANCE METER

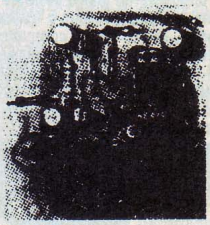
This Digital Capacitance Meter checks values from 1pF tp 9.99µF over three ranges. Its main features include a nulling circuit and bright 4-digit LED display.

EA Aug'85

~~$99.95~~

SPECIAL AT $49.95

BALANCE MICROPHONE AMPLIFIER



High-quality transformer for matching balanced microphones into unbalanced inouts are quite expensive. This simple preamplifier will accepts balanced inputs directly. ***ETI May 1977.***

K10060 ~~$12.95~~ NOW $11.00

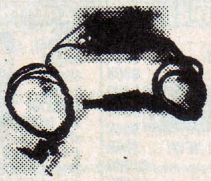
BALANCED INPUT DIFFERENTIAL PREAMP

This versatile little preamp has a host of applications in the audio-and-beyond range, not the least of which would be as a balanced mic preamp.

ETI Dec 1982.

K10070 ~~$19.95~~ NOW $16.95

NICAD FLOAT CHARGER



This NiCad battery charger provides a happy medium between fast chargers and constant-current chargers. It's cheap, simple to build and will bring a battery to full charge from complete discharge in 12 hours - then keep it there. And your NiCads are safe from overcharging damage. ***ETI Mar 1983.***

K10075 ~~$14.95~~ NOW $12.70

GENRAL PURPOSE AUDIO AMPLIFIER MODULE

One of the handiest "tool" for the electronics experimenter is a genuine general purpose audio amp. This module will work from a wide range of supply voltages, has good sensitivity, is robust and reliable - easy to build too! ***ETI April 1980.***

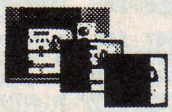
K10065 ~~$14.95~~ NOW $12.70

IN-CIRUIT TRANSISTOR TESTER

Do you have a boxful of unknown transistors or a transistor circuit that's not working properly? This simple tester will indicate whether a transistor is working or not & tell you whether it is an NPN or PNP type. ***Silicon Chip Sept 1993.***

K10200 ~~$14.95~~ NOW $12.70

COLOUR VIDEO FADER



Forget those messy edits on your VCR! This project uses readily available components & smoothly fades any composite PAL video signal to black level to enhance your home movies. It can also wipe left or right across the screen for special effects.

Silicon Chip Aug 1993.

K10405 ~~$32.95~~ NOW $28.00

3 DIGIT COUNTER MODULE

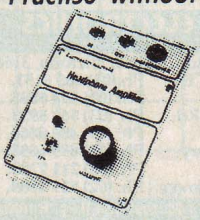
Looking for a cheap module for event counting or to be used as part of a larger project? If so, consider this 3-digit counter module. It uses only two low-cost CMOS ICs and can be put together in a couple of hours.

Silicon Chip Sept 1990.

K10105 ~~$23.95~~ NOW $20.35

HEADPHONE AMPLIFIER

Practise without annoying the family



This is just perfect for those who play any type of musical instruments at home. It will let you practise for hours without upsetting the household, or you can use it to monitor your own instrument in the midst of a rowdy jam session.

EA Feb 1994.

K10315 ~~$34.95~~ NOW $29.70

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REMOTE CONTROL

BY BOB YOUNG

A multi-channel radio control transmitter for models; Pt.1

This month, we introduce the new Mark 22 transmitter which is a continuation of the series which has featured the Mark 22 receiver & 8 & 16-channel decoders. This new transmitter is right up to date but employs discrete components rather than a custom microprocessor.

In response to all those who must have missed the first article in this series and have rung or written with "the" question, I am happy to state that "Yes Virginia, there is a transmitter". Here it is in all its glory.

What we are presenting is a 4-channel transmitter in the standard modelling layout with two dual-axis control sticks. The toggle switch on the top left is the dual control change-over switch. The dual control socket and master select switch is on the bottom of the case. The ON-OFF switch is under the black cover between the two joysticks and the charge socket is just below. The charge socket plays an important secondary role, as we will soon see. The trim levers are located in the traditional spots on the joystick surrounds and a meter rounds out the complement of displays and controls.

In subsequent articles, I will present photographs of various transmitters of up to 32 channels and the circuits for 24 channels. The encoder module simply strings together so that you can have multiples of 8, 16, 24 and 32 channels or more if required. Remember here that servos start to slow down after 24 channels unless modified. Construction details will not be presented for transmitters above eight channels.

I have to tell you that with the normal difficulties encountered with electronic development and suppliers breaking their promises, the path for manufacturers is far from smooth. (And I might add, the playing field is far from level). No wonder Australian manufacturers long ago learned the value in picking up the phone and ordering their equipment complete and off-the-shelf from overseas.

This time around, I have run into problems with the second harmonic on the transmitter output being higher than legally permissible which, of course, has prevented publication of the circuit until the levels are correct. At the time of writing, this problem has finally been overcome but sadly too late for publication this month.

Table 1: Channel Functions

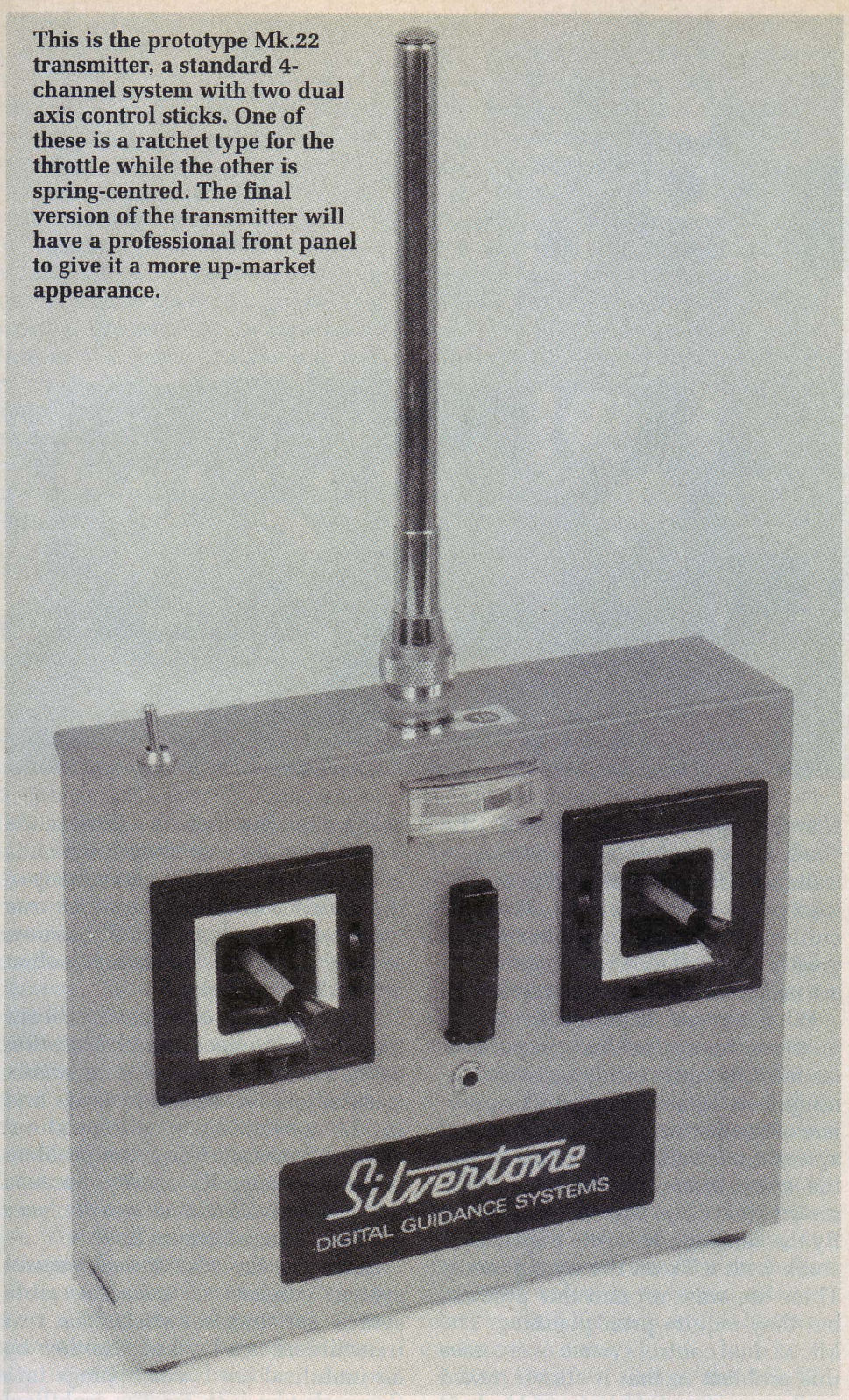
Channel	Function
1	Throttle
2	Aileron
3	Elevator
4	Rudder
5	Retracts (Toggle Switch)
6	Aux. Slide 1
7	Aux. Slide 2
8	Toggle Switch 2

That leads into the first discussion for this month and that is the final format of the RF module. I had intended to make this module available as a kit but its tuning really does require a spectrum analyser to meet the legal requirements, so I have decided to supply the RF module as a finished and tuned module only. The RF circuit will still be published and the encoder will still be available as a kit, as will the mechanics.

As you can see from the photos, the new transmitter is a true modular system which will facilitate servicing in the field, with a change-over fee being charged for module replacements. The same applies to the receiver and also do not forget, all of the components are available in Australia and the circuits readily available. All of this should go a long way to alleviating the service problems commonly encountered in the model business, as this system should be within the capability of any competent serviceman.

If you have a look at the decoder board in the photos, you will notice that there are seven rows of header pins on the righthand side. These pins are the connectors for the control potentiometers. These pins perform an important function in the overall design. Firstly, they allow the module to be easily removed from the transmitter. Secondly, they provide the servo reversing function.

Each set of three pins is arranged with the wiper on the centre pin and the positive and negative supply on the outside pins. Thus, by rotating the connector through 180°, servo reversing is achieved. Thirdly, they provide channel shuffling, a very important feature in the Mk.22 system. As there



This is the prototype Mk.22 transmitter, a standard 4-channel system with two dual axis control sticks. One of these is a ratchet type for the throttle while the other is spring-centred. The final version of the transmitter will have a professional front panel to give it a more up-market appearance.

is no standardisation on the arrangement of the channel numbering between manufacturers, channel shuffling allows the transmitter to be tailored to suit any brand of receiver you may own.

Channel allocation

This is an important point if you are using a Mk.22 transmitter with an aircraft that is already set up. Thus, there is no need to disturb the servo connectors in the model – the correct channel allocation can be set up in the transmitter instead. Note that the encoder module shown is an early development module and not the production version.

I recommend the channel allocation shown in Table 1.

These are not arbitrary allocations. They are specified this way for the following reasons: (1) incoming noise affects the first channel more than any of the others; and (2) as the encoder is a sequential pulse generator, a failure after channel 5 will still leave the main flying controls operational. Other manufacturers have other ideas and Futaba, for example, use Aileron, Elevator, Throttle, Rudder, Retracts, Aux 1, Aux 2 and Toggle 2; that is, when they are not mixing, matching or mode changing. In this case, anything can be anywhere. For example, they recommend leaving the channel allocation untouched during mode changes which means throttle and elevator can be reversed.

At Silvertone, we insist on the channel allocation remaining constant when changing modes, for reasons which will be explained later.

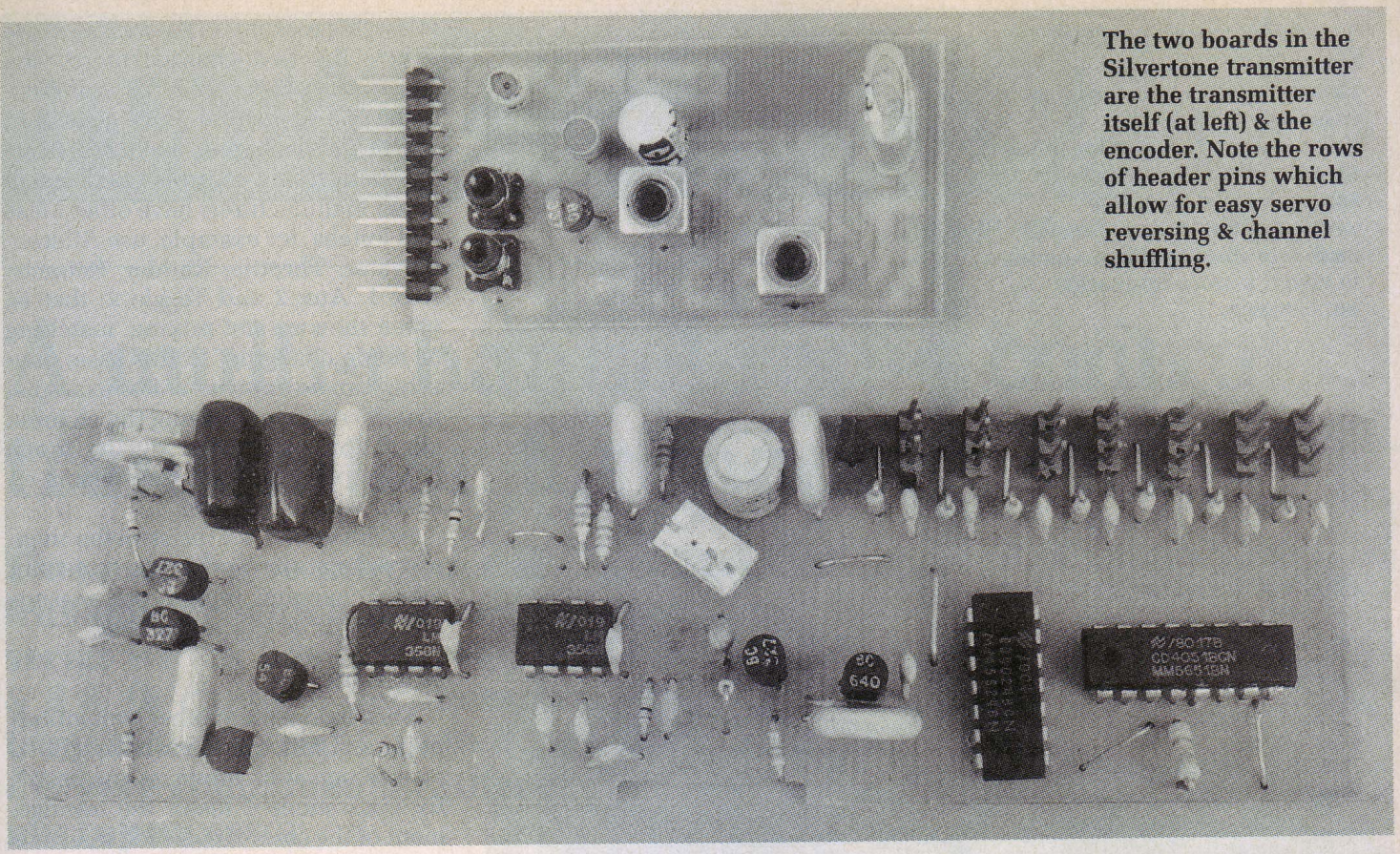
Stick modes

Stick modes are another contentious point and much ink has been spilled over which stick mode is "the best!". By stick mode I mean the arrangement of the controls on each dual axis joystick assembly. There are two basic stick configurations, spring-centring and ratchet. The spring return sticks are used for the flying controls. (I will refer here to the flying controls because they are usually more numerous than the steering controls on a car or boat). The ratchet configuration is used for throttle or any non-centring control.

Now the fun begins when you try to decide on the grouping of these controls on the two stick assemblies. Modelling convention has defined Mode 1 as Throttle and Aileron on the right hand stick and Elevator and Rudder on the left hand stick. Mode 2 is generally defined as Aileron/Elevator on the right and Rudder/Throttle on the left. Even here you will encounter some conflict as it is sometimes defined in reverse.

The purist will insist that real aircraft are flown with Mode 2 and that models should be flown likewise. For a great many other reasons, all valid, there are others who insist that the two primary flying controls should be separated, as we use our thumbs, not our wrists.

As a general rule, aerobatic and pylon fliers will fly Mode 1 and scale buffs Mode 2. Most beginners are heavily influenced by their instructors and often a club will show a preference to



The two boards in the Silvertone transmitter are the transmitter itself (at left) & the encoder. Note the rows of header pins which allow for easy servo reversing & channel shuffling.

one mode as a result of the availability of instructors. I think these days that Mode 1 is more common but choice of mode is a very personal thing and best left to the individual to decide on. I began by flying Mode 2 as a result of my instructor's influence but never felt comfortable on this mode. I subsequently changed to Mode 1, with a dramatic improvement in my standard of flying.

The Mk.22 Tx is very simple to change modes on and when we come to the mechanical assembly I will present the details. The channel shuffling facility removes any need for soldering in this process. In some transmitters, mode changing is a tricky business, not to be undertaken by the fainthearted or unskilled.

Dual control

The stick mode problem rears its head again when the dual control facility is being designed. Dual control is a very valuable asset in any transmitter, particularly in clubs where training is a big item. Model aircraft are very difficult to learn to fly and some form of instruction is desirable, at least in the early stages. The MAAA (Model Aeronautical Association of Australia) has now adopted the RCAS (Radio Control Aircraft Society of NSW) flight training system (the "buddy" system), so all clubs in Australia now have a unified flight training system. Drop outs due to the difficulties in learning to fly have been greatly reduced as a result and clubs are now at record membership levels.

What has not been unified is the dual control system and, in particular, the difficulties of mixing two transmitters on different modes. The problem arises because most dual control systems only allow the pupil to use the slave (non-radiating Tx) which means that if the instructor does not fly the same mode as the pupil, he is stuck with a Tx on the wrong mode. There are ways around this problem but they require prior planning. The Mk.22 dual control system overcomes this problem in that it allows mixed mode operation (Mode 1 and Mode 2) as well as master/slave configuration, a feature not found on any other system to my knowledge.

This now opens the way to instructors being able to teach people to fly on the opposite mode. I should mention that it is very difficult to fly both modes, as reflex action gets in the way, due to the speed at which the models fly. Most people will not fly a model on the wrong mode. This includes a lot of instructors. I used to fly both modes but there is a third mode which I could never master, which is aileron/elevator with a knob on top of the stick for rudder. This was a true three-axis system, commonly known as single stick. It is not seen too often on fields these days.

Now it becomes obvious why Silvertone insists on the channel allocation being constant, if we are going to mix transmitters on different modes and in the master/slave configuration. With channel shuffling, the problem becomes academic anyway, because the channel allocation can be very quickly changed on the field.

Basically, the Mk.22 dual control system consists of a socket, slide switch and toggle switch. The two transmitters are hooked together by an umbilical cord which plugs into this socket on each Tx. The umbilical carries the data from the encoders. The slide switch selects which encoder and which RF module will be paired. The toggle switch on the top of the transmitter is a spring loaded OFF type. Thus, the instructor hands over control to the pupil with the toggle switch and if things start to go pear-shaped, then he just grabs for his controls and the spring toggle automatically returns control to his transmitter.

Thus, not only can mixed mode operation be achieved but the pupil can be given the transmitter with the antenna from the very beginning, thereby teaching him to position the antenna for the best radiation match with the receiver antenna from the outset – a very important point in flight training. This arrangement with the instructor on the transmitter without the antenna is most unusual and is called master/slave mode. It also allows the instructor to take the master transmitter (with antenna) if he prefers it that way, and he flies the same mode. As I am running out of space, I will leave the description of the mixing aspects of dual control for a later issue.

Frequency interlock

Another unusual feature of the Mk.22 Tx is the frequency interlock system. In 1969, Silvertone pioneered narrow-band spacing (15kHz) in Australia and to control these frequencies we had to develop the Silvertone Keyboard. The original keyboard featured 57 slots at 5kHz spacing. This was to allow mixing of all the known frequency spacing systems available from anywhere in the world.

At that time, all countries had allocations on 27MHz but there was no standardisation of the frequency spacings. Thus, we had sets of crystals on 10, 15, 20, 25, 30 and 50kHz spacings, all appearing on the field at the same time. We also had 1.5", 2", 3" and 4" keys in the board at any one time. I can clearly remember the day in 1969 when we had 16 aircraft in the air at one time. This is common enough these days but unheard of then. The Mk.22 system, incidentally, is cleared for 20kHz spacing (2" key).

Frequency control had degenerated into a nightmare and thus we were forced to develop the keyboard. Basically the modern keyboard consists of a graphical display of the frequency allocation on a 1" = 10kHz grid. The original keyboard was designed on a 0.5" = 5kHz grid which fell by the wayside when frequency spacings were standardised on 10kHz.

A frequency key whose width is proportional to the bandwidth of the system in use, is slid into the keyboard, thus reserving the frequencies required for safe operation of that system. Nothing new here, most clubs have been using this for years and it is now the system required for all MAAA-sanctioned events in Australia. At the time of its introduction, however, it was the most democratic and revolutionary system seen on flying fields anywhere in the world.

The Mk.22 Tx, however, carries this concept to its logical conclusion. If each modeller on the field has his own personal key, why not plug it into the transmitter when this key is not in use and cut off all power to the transmitter? This renders the transmitter inoperable at all times when the key is not in the keyboard. Thus, we now have a true frequency interlock system – end of accidents involving transmitters left on inadvertently in transmitter pound, a not too infrequent occurrence.

In the Mk.22 TX the charge socket doubles as the frequency interlock. Thus each frequency key is fitted with a plug which plugs into the charge socket, thereby cutting off power when the Tx is not in use.

Again, there is nothing new here. I introduced this concept with the original keyboard in 1969. The mistake I made then, however, was to patent the system. This meant that had the system been adopted, all sets imported into Australia would have been forced to pay a royalty.

The importers went berserk. The system was the subject of a campaign which kept it out of use until the patent expired. After that, the keyboard was adopted as Australian standard and offered for sale by the same importers who so vehemently opposed the system whilst the patent held up. Unfortunately, the frequency interlock fell by the way. However, that does not stop me from using it and all Silvertone transmitters built from 1969 onwards have had it built in as standard. Of such stuff is history made.

I have tried to design the Mk.22 system so that it does not compete head-on with imported equipment. By taking well-developed concepts that we pioneered in the past and combining them with modern concepts and technology, as well as building in the utmost flexibility and serviceability, I believe that I have achieved this goal. The Mk.22 is a unique and interesting system and one that will find many uses in the field of hobby, sporting and commercial radio control. Next month, the circuit. I promise. **SC**

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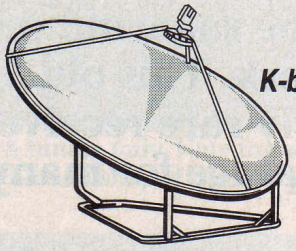

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VINTAGE RADIO

By JOHN HILL

The 5-valve Darelle receiver

Restoring some old receivers takes a lot of hard work. This old 5-valve superhet is a relatively rare receiver that had been stored in my garage for many years.

Recently, while admiring a fellow enthusiast's radio collection, I noticed an odd-looking Darelle receiver – a 1932 console model to be precise. The reason I recognised this relatively rare radio is because I had one exactly the same stored in my shed.

My Darelle had been hidden away since the day I found it with its broken cabinet (the bottom section had separated) and non-functioning receiver. Seeing a nicely restored Darelle must have triggered some sort of subconscious response because the very next day I dragged my old wreck out for a closer inspection.

After removing the chassis from the broken cabinet, I discovered to my surprise that the Darelle is a 5-valve superhet. I had been under the impression that it was a TRF (tuned radio frequency) type receiver but, as it has two intermediate frequency (IF) transformers, it is clearly not a TRF. That just goes to show how little attention I paid to the set when I put it into storage.

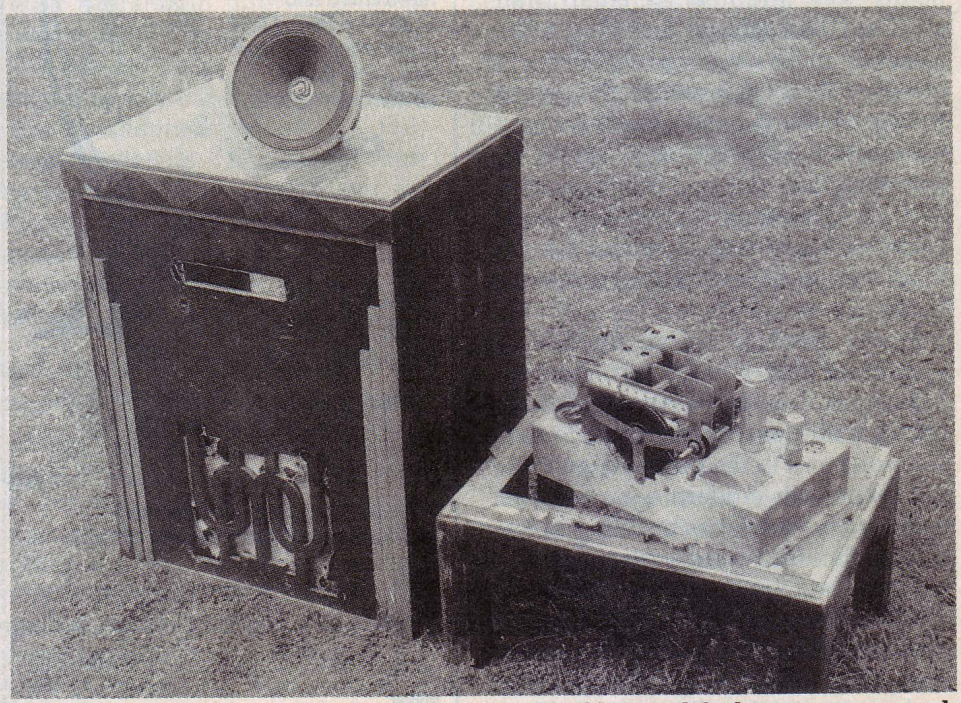
Because it is a 1932 model, one would assume that it has 2.5V valves and it has. However, where one might expect it to have a front-end line-up of a 57, 58 and 57, the old Darelle has a 24, 35 and 24, followed by a 47 output. There is also the obligatory 80 rectifier. In other words, it is an early autodyne superhet which was the industry standard for console radios in the early 1930s.

The cabinet lacks style, even though it stands on legs. They are not nice turned legs but square-sectioned ones which simply do not have the same appeal. The box-shaped cabinet has all flat surfaces with square corners and the fretwork in the speaker opening is decidedly heavy looking. The front is veneered with a simple pattern of triangular shapes across the top.

In summary, it is a fairly unimaginative design – plain but functional. Well, that's how it seems to my eyes.

Like so many receivers from the early 1930s, the Darelle appears to be made for a price. It is a straightforward basic receiver in a cheap, lightweight plywood cabinet and was basically a budget-priced radio for the depression years!

The cabinet was in poor condition, to say the least. The veneer had lifted on the top surface and broken away at the edges. There were also several small chips of veneer missing from the front and the base and legs were completely detached. Nevertheless, it was not a total write off. With a bit of perseverance (a fair bit actually), it would restore reasonably well.

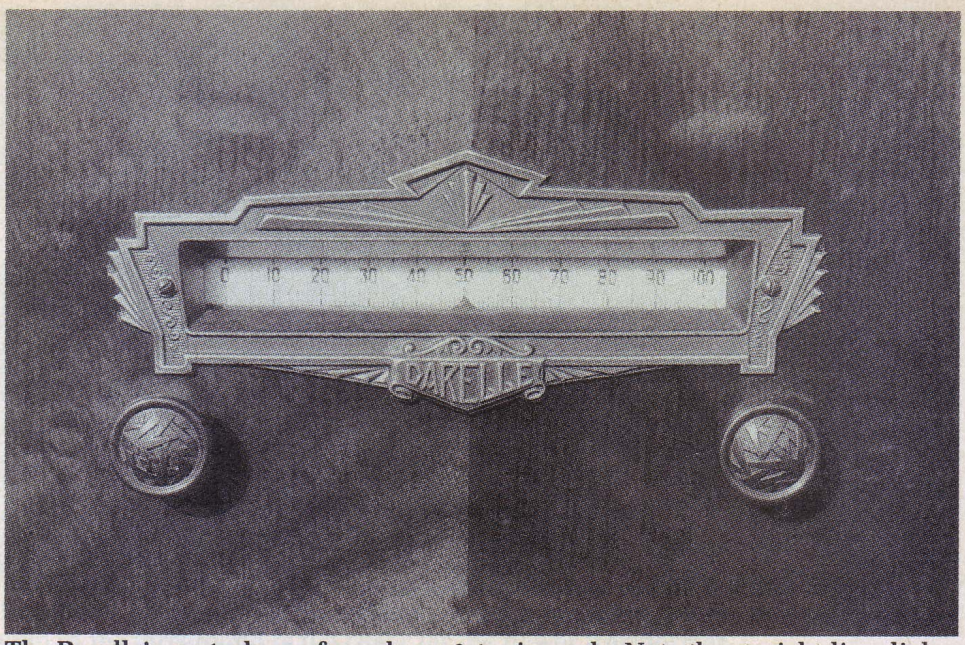


This is how the derelict Darelle, with its detached base & lifted veneer, appeared after it was hauled out of the garage. It wasn't a job for the faint-hearted.

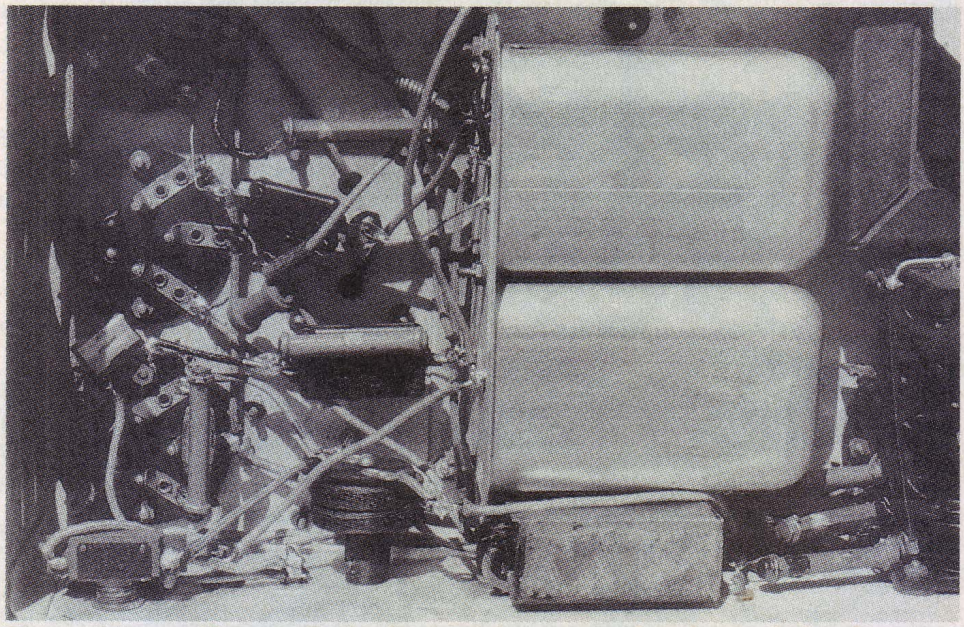
Chassis restoration

I never consider doing anything to a radio cabinet until the receiver is working again. There is little point in restoring a cabinet only to find that

After refurbishing, the cabinet looked as good as new. It was glued back together & had a new top fitted. But regardless of the improvements, it still looks like a glorified tea-chest on legs.



The Darelle's controls are for volume & tuning only. Note the straight-line dial which was unusual for 1932 when half-moon shaped dials were all the go.



The aerial & oscillator coils (in the cans) are mounted underneath the chassis. Note the small block capacitor wedged in between the chassis & the bottom can. The Darelle is not a particularly easy receiver to work on.

the rest of the set is irreparable for some reason. And so, with this thought in mind, I set about restoring the chassis and speaker to working order.

The usual routine checks cleared everything except the output transformer which had an open-circuit primary winding. This common vintage radio repair problem was easily overcome by replacing the defective component with an M-1100 audio line transformer from Dick Smith Electronics. The M-1100 is rated at 5kΩ to 2, 4, 8 or 16Ω and, although never meant to be a valve output transformer, it does a remarkably good job and at $7 is quite cheap.

Being much smaller than the original output transformer, the M-1100 was installed inside the mounting cover of the older unit. This helps to disguise it so that it is not too obvious (at least at first glance) that a modern unit has been used.

The paper capacitors were a mix of tubular cardboard types plus a small block capacitor with four 0.3µF 1000V capacitors inside it. This block was situated in a very inaccessible place and required the removal of the aerial and oscillator coils in order to gain access to it.

As the screws that held the aerial and oscillator coils in place also secured the tuning capacitor, it too was removed. Its rubber mountings had perished to almost nothing and the plates were scrapping badly and needed attention.

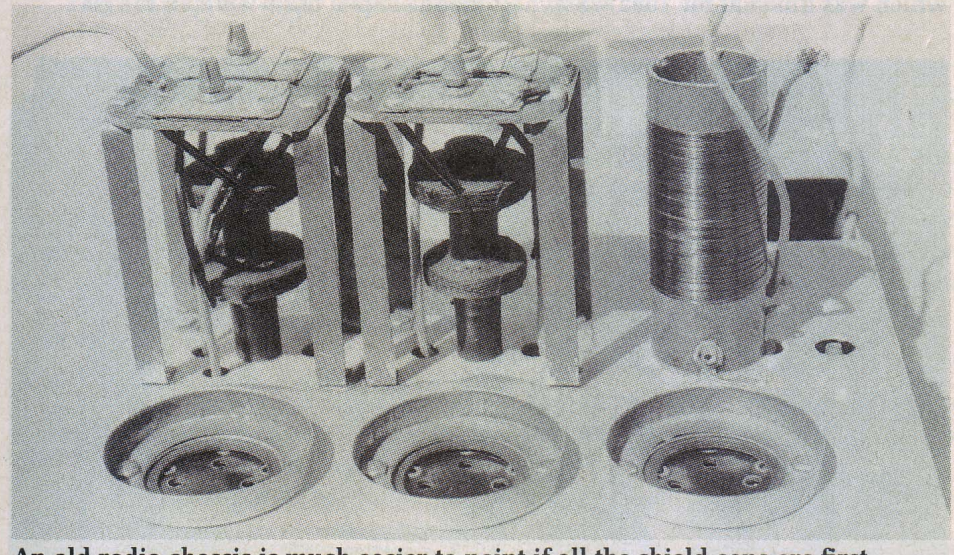
Tuning gang repairs

I had experienced similar troubles before with this make of tuning capacitor and it seems as though it nearly always presents a problem.

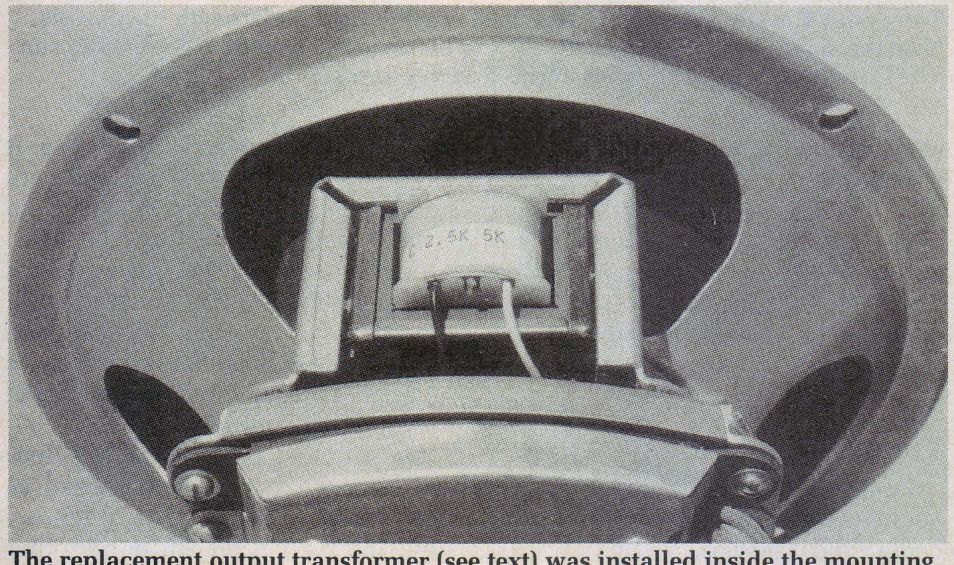
This capacitor is a plain bearing type and is of riveted construction. It would appear that the rivet holes are much larger than the rivets and so the rivets slacken their grip over the years. This allows the rather strong thrust spring at the rear of the control spindle to spread the front and rear end plates of the body, so that all three sets of movable plates shift forward until they foul the stationary plates.

The method of construction does not allow the rivets to be tightened, as there is no room to fit anything behind the rivet head while the other end is tapped with a hammer. And because the body is made of alu-

The chassis repairs involved the usual replacement of paper capacitors & a few resistors that had gone high. The capacitor can is dated May, 1932.



An old radio chassis is much easier to paint if all the shield cans are first removed. This also allows components such as the IF transformers to be inspected & cleaned.



The replacement output transformer (see text) was installed inside the mounting cover of the original transformer. This technique helps to disguise the modern component, so that it doesn't look out of place.

minium, it cannot be soldered.

One repair technique that does work with these tuning capacitors is to first squeeze the end plates back into position using large G clamps, then glue them permanently in place with super glue.

Although a simple remedy, it seems to work OK. But first, because the tuning capacitor has plain bearings that had never been cleaned or lubricated, the main control shaft was withdrawn and the unit dismantled. Each set of movable plates was numbered so that they would go back in their respective positions.

Completely dismantling the capacitor is the only way it can be properly cleaned and the bearings lubricated with grease.

After re-assembly, the individual capacitance of each gang was checked with a capacitance meter to ensure that they were in step with each other. This was done with the trimmers slackened right off. It is important that the three gangs track each other closely, otherwise the receiver will be difficult to align. Finally, new rubber grommets were used to remount the rebuilt tuning capacitor.

All up, the tuning capacitor repairs plus the block capacitor rebuild took quite some time to complete.

Incidentally, while the tuning capacitor was removed, it was an opportune time to clear the rest of the top hardware and paint the chassis. The chassis received a coat of aluminium paint, while the other bits and pieces were painted bronze. It certainly looked better after this had been done.

Switch on

When the big moment came to try it out, it was a bit of a disappointment because the set worked very feebly on the local station only. After some investigations, the problem was found to be a faulty type 35 valve and "donging" it sent the sound into convulsions.

After fitting another valve, the set worked much better than before but desperately needed aligning.

It is interesting to note that the faulty valve checked out OK in the valve tester, which supports statements I have made before concerning the value of such tests. A valve tester only indicates that a valve has adequate emission. One can never be sure that it does not have other faults until it has

been installed in a receiver and given a thorough workout.

Alignment

The first step in the alignment procedure involved setting the IF transformers to 175kHz. They were badly out of adjustment and a considerable improvement in gain was noted after they had been correctly aligned.

A problem arose when aligning the aerial and oscillator circuits because the padder circuit would not track. The padder screw tightened up solid before the output meter could be peaked while searching for maximum output at the low frequency end of the dial. This suggested that the padder lacked sufficient capacity to cover the necessary adjustment range.

In fact, the padder was relatively small in capacity and was bridged with a mica capacitor. This mica capacitor was removed and one approximately 60pF larger was installed in its place. The padder circuit could then be made to track. This is important because if the padder is out of adjustment, it can result in poor reception at various points of the dial.

The tuning capacitor trimmers also needed considerable adjustment. However, alignment when using a radio frequency generator is fairly straightforward, even when the adjustment screws have been disturbed.

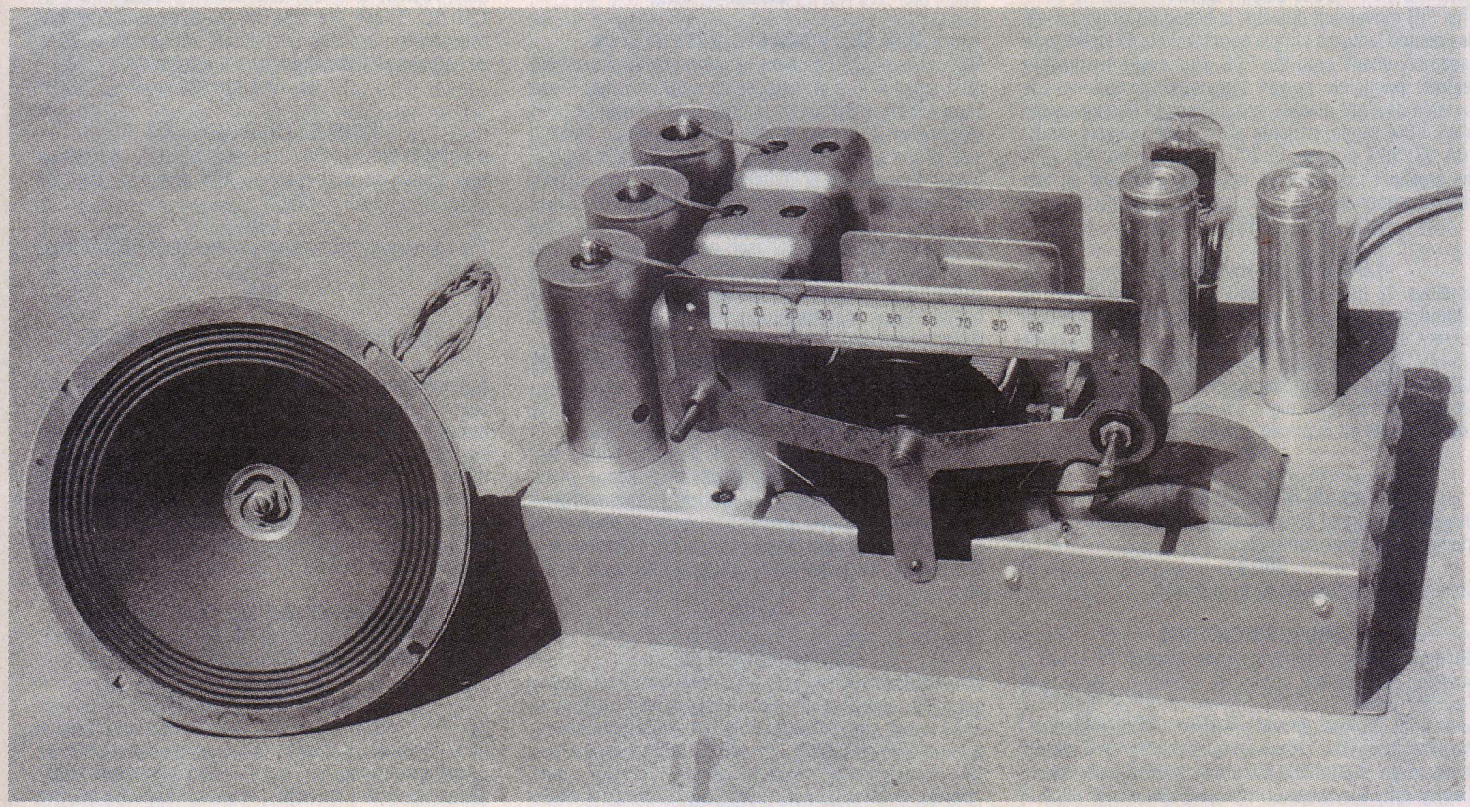
The repaint job greatly improved the general appearance of the chassis. The hump in the foreground is the cover for the power transformer.

Cabinet restoration

Well, that finished that part of the restoration. It was time to do something with that horrible cabinet; and cabinet repairs I can put off forever.

Now it just so happens that I know someone who does a fairly good job of cabinet refurbishing and I reckoned he owed me a favour or two. He likes doing up old radio cabinets so much he couldn't say no – even to the Darelle's multi-piece pile of plywood and termite food.

As can be seen in one of the accompanying photographs, the cabinet is not only in one piece again but looks every bit as good as the day it was made. It has had a new top fitted and there is little evidence as to its prior condition. It's marvellous what a bit of time and effort can do. **SC**



This view shows the fully restored chassis & its companion loudspeaker. The chassis design is typically early 1930s – an autodyne superhet with anode bend detection. The old Magnavox loudspeaker still has a perfect cone, which is quite remarkable considering its age.

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$7990

OPTICS

USSR LENS 100mm-f2 Pentax screw mount thread, as used for night viewers, has focus adj. but no iris adj.: $60. **USSR LENS** 58mm-f2 Pentax screw mount lens as used for cameras, has focus and iris adj.: $60. **BEAM SPLITTER** for 633nm: $45. **PRECISION FRONT SURFACE ALUMINIUM MIRRORS** 200 x 15 x 3mm: $3. 50 x 72 x 3mm: $3. **LINE GENERATING OPTIC** makes a line out of a laser beam: $5. **LASER DIODE COLLIMATING LENS:** $4. **PORRO 90 deg. PRISM** makes a rainbow from white light: $10. **PRECISION ROTATING MIRROR ASSEMBLY** as used in levelling equipment, needs small motor/belt, plus a laser beam, will draw a line right around a room (360 deg.) with a laser beam: $45. **ARGON MIRRORS** high reflector and output coupler used to make a Argon tube: $50.

27MHz TRANSMITTERS

New transmitters are assembled (PCB assy.) and tested. They are Xtal locked on 26.995 MHz and were originally intended for transmitting digital information. Their discrete component design employs many components, including 5 transistors and 8 inductors. Circuit provided. A heatsink is provided for the output device. Power output depends on supply voltage and varies from 100mW to a few watts, when operated from 3-12V DC. These are sold for parts/experimentation/educational purposes, and should not be connected to an antenna as licensing may be required:

$7 ea. or 4 for $20

VISIBLE LASER DIODE KIT

A 5mW/670nm visible laser diode plus a collimating lens, plus a housing, plus an APC driver kit (Sept 94 EA) UNBELIEVABLE PRICE:

$40

The same kit is also available with a 3mW/650nm laser diode:

$65

LOW COST 1-2 CHANNEL UHF REMOTE CONTROL

A single channel 304MHz UHF remote control with over 1/2 million code combinations which also makes provision for a second channel expansion. The low cost design includes a complete compact keyring transmitter kit, which includes a case and battery, and a PCB and components kit for the receiver that has 2A relay contact output!. Tx kit $10, Rx kit $20, additional components to convert the receiver to 2 channel operation (extra decoder IC and relay) $6. INCREDIBLE PRICES:

COMPLETE 1 CHANNEL TX-RX KIT: $30
COMPLETE 2 CHANNEL TX-RX KIT: $36
ADDITIONAL TRANSMITTERS: $10

3 STAGE NIGHT VIEWER KIT

See SC, September 1994. We have accumulated a good number of 40mm three stage fibre optically coupled three stage image intensifiers that have minor blemishes. The three tubes are supplied already bonded together and have extremely high gain!! We can supply this three stage intensifier tube plus a power supply kit

plus a lens and an eyepiece for a total cost of only:
$250
That is an almost complete starlight night viewer kit! We can also supply the full SC Sept 94 Magazine: $5.

VISIBLE LASER DIODE MODULES

Industrial quality 5mW/670nm laser diode modules. Overall dimensions: 11mm diameter by 40mm long. Have APC driver built in and need approximately 50mA from 3-6V supply.
$60

VIDEO TRANSMITTERS

Low power PAL standard UHF TV transmitters. Have audio and video inputs with adjustable levels, a power switch, and a power input socket: 10-14V DC/10mA operation. Enclosed in a small metal box with an attached telescopic antenna. Range is up to 10m with the telescopic antenna supplied, but can be increased to approximately 30m by the use of a small directional UHF antenna. INCREDIBLE PRICING:
$25

12V FANS

Brand new 80mm 12V-1.6W DC fans. These are IC controlled and have four different approval stamps:
$10 ea. or 5 for $40

TDA ICs/TRANSFORMERS

We have a limited stock of some 20 Watt TDA1520 HI-FI quality monolythic power amplifier ICs: less than 0.01% THD and TIM distortion, at 10W RMS output! With the transformer we supply we guarantee an output of greater than 20W RMS per channel into an 8ohm load, with both channels driven. We supply a far over-rated 240V-28V/80W transformer, two TDA1520 ICs, and two suitable PCBs which also include an optional preamplifier section (only one additional IC), and a circuit and layout diagram. The combination can be used as a high quality HI-FI Stereo/Guitar/P.A., amplifier. Only a handful of additional components are required to complete this excellent stereo/twin amplifier! Incredible pricing:
$25
For one 240V-28V (80W!) transformer, two TDA1520 monolythic HI-FI amplifier ICs, two PCBs to suit, circuit diagram/layout. Some additional components and a heatsink are required.

TWO STEPPER MOTORS PLUS A DRIVER KIT

This kit will drive two stepper motors: 4, 5, 6 or 8 eight wire stepper motors from an IBM computer parallel port: motors require separate power supply. A detailed manual on the COMPUTER CONTROL OF MOTORS plus circuit diagrams/descriptions are provided. We also provide the necessary software on a 5.25" disc. Great "low cost" educational kit. We provide the kit, manual, disc, plus TWO 5V/6 WIRE/7.5 deg. STEPPER MOTORS FOR A SPECIAL PRICE OF:
$42

BIGGER LASER

We have a good, but LIMITED QUANTITY of some "as new" Helium Neon (red) 6mW+ laser heads that were removed from new equipment. Head dimensions: 45mm diameter by 380mm long. With each of the heads we will include our 12V universal laser power supply. BARGAIN AT:
$170 6mW+ head/supply. ITEM No. 0225B
We also have a limited number of used He-Ne tubes. Used 1-3mW tube plus our 12V Universal Laser power supply: $65

12V-2.5 WATT SOLAR PANEL KITS

These US made amorphous glass solar panels only need terminating and weather proofing. We provide terminating clips and a slightly larger sheet of glass. The terminated panel is glued to the backing glass, around the edges only. To make the final weatherproof panel look very attractive some inexpensive plastic "L" angle could also be glued to the edges with some silicone. Very easy to make. Dimensions: 305 x 228mm, Vo-c: 18-20V, Is-c: 250mA. SPECIAL REDUCED PRICE:
$20 ea. or 4 for $60
Each panel is provided with a sheet of backing glass, terminating clips, an isolating diode, and the instructions. A very efficient switching regulator kit is available: suits 12-24V batteries, 0.1-16A panels, $27. Also available is a simple and efficient shunt regulator kit, $5.

SOLID STATE "PELTIER EFFECT" DEVICES

These can be used to make a solid state thermoelectric cooler-heater. Basic information supplied:
12V-3.4A PELTIER: $25
12V-4.5A PELTIER: $35
We can also provide two thermal cutout switches, and a 12V DC fan to suit either of the above, for an additional price of $10.

VEHICLE COMPUTERS

Originally designed for bicycles, but these suit any moving vehicle that has a rotating wheel! A nine function computer with speed, average speed, maximum speed, distance, odometer, timer, scan, freeze frame memory, and a clock. Its microprocessor based circuitry can be adapted to work with almost any wheel diameter. Simply divide the wheel diameter in millimetres by 6.8232, and program the resultant figure into the computer.
$29.90

MORE KITS

MODEL TRAIN CONTROLLER: run two trains on one track without any collisions, uses kit IR LEDs/transistors for detectors (supplied), doubles up as a crossing controller with flashing crossing LEDs. Incredible pricing: $20. **TRAIN SOUND GENERATOR:** can be used in conjunction with the controller to produce crossing and other sounds, when a train is on a particular part of a track: $12. **SINGLE CHANNEL UHF REMOTE CONTROL:** SC Dec 92, 1 x Tx plus 1 x Rx: $45, extra Tx $15. **4 CHANNEL UHF REMOTE CONTROL KIT:** two transmitters and one receiver: $96. **GARAGE-DOOR-GATE REMOTE CONTROL KIT:** SC DEC 93: Tx $18, Rx $79. **1.5-9V CONVERTER KIT:** $6 ea. or 3 for $15. **LASER BEAM COMMUNICATOR KIT:** Tx, Rx, plus IR Laser: $60. **ELECTRIC FENCE KIT:** PCB and components, includes prewound transformer: $40. **PLASMA BALL KIT:** PCB and components kit, needs any bulb: ON SPECIAL $20. **MASTHEAD AMPLIFIER KIT:** two PCBs plus all on board components, low noise (uses MAR-6 IC), covers VHF-UHF: $18. **BRAKE LIGHT INDICATOR KIT:** 60 LEDs, two PCBs and ten Rs, makes for a very bright 600mm long high intensity red display: ON SPECIAL $25. **FM TRANSMITTER KIT - MKII:** high quality - high stability, suit radiomicrophones and instruments, 9V operation, the kit includes a PCB and all the on-board components, an electret microphone, and a 9V battery clip: $11. **FM TRANSMITTER KIT - MK1:** this complete transmitter kit (miniature microphone included) is the size of an "AA" battery, and it is powered by a single "AA" battery. We use a two "AA" battery holder (provided) for the case, and a battery clip (shorted) for the switch. Estimated battery life is over 500 hours!!: $11. **PROTECT ANYTHING ALARM KIT:** EA May 93, ON SPECIAL, PCB and all on-board components kit: $20. **ELECTRIC FENCE KIT:** SC April 94: ON SPECIAL: $28. **ELECTRONIC KEY KIT:** EA July 92, 2 keys plus one receiver, ON SPECIAL: $30.

MORE ITEMS

PRINTER MECHANISMS: brand new Epson dot matrix printer mechanisms, overall dimensions are 150 x 105 x 70mm: $12. **CD MECHANISMS:** used compact disc player mechanisms that contain optics, small conventional DC motor, gears, magnets etc.: $6 with conventional motor, $4 with linear motor, broken CD mechanisms $2.50. **SWITCHED MODE POWER SUPPLIES:** mains in (240V), new assembled units with 12V-4A and 5V-4A DC outputs: $32. **INDUCTIVE PROXIMITY SWITCHES:** detect ferrous and nonferrous metals at close proximity, AC or DC powered types, three wire connection for connecting into circuitry. Two for the supply, and one for switching the load, these also make excellent sensors for rotating shafts etc.: $22 ea. or 6 for $100. **IEC EXTENSION LEADS:** 2M long, IEC plug at one end, IEC socket at other end: $5. **MOTOR SPECIAL:** Type M9: 12V, I No load = 0.52A-15,800 RPM at 12V, 36mm diam., 67mm long: $5, Type M14: made for slot cars, 4-8V, I No load = 0.84A at 6V, at max efficiency I = 5.7A-7500 RPM, 30mm diam., 57mm long: $5. **EPROMS:** 27C512, 512K (64K x 8), 150nS access CMOS EPROMS, removed from new equipment, need to be erased, guaranteed: $4. **MODULAR TELEPHONE CABLES:** 4 way modular curled cable with plus fitted at each end, also an 4M long 8 way modular flat cable with plugs fitted at each end, one of each for: $2. **POLYGON SCANNERS:** precision motor with 8 sided mirror, plus a matching PCB driver assembly. Will deflect a laser beam and generate a line. Needs a clock pulse and DC supply to operate, information supplied: ON SPECIAL $15. **PCB WITH AD7581LN IC:** PCB assembly that amongst many other components contains a MAXIM AD7581LN IC: 8 bit, 8 channel memory buffered data acquisition system designed to interface with microprocessors: $29. **EHT POWER SUPPLY:** out of new laser printers, deliver -600V, -7.5kV and +7kV when powered from a 24V-800mA DC supply, enclosed in a plastic case: $16. **MAINS CONTACTOR RELAY:** has a 24V-250ohm relay coil, and four separate SPST switch outputs, 2 x 10A and 2 x 20A, new Omron brand, mounting bracket and spade connectors provided: CLEARANCE @ $5 ea. **SUPERCAPS:** 0.047F/5.5V capacitors: 5 for $2. **PCB MOUNTED SWITCHES:** 90 deg. 3A-250V, SPDT: 4 for $2. **3" CONE TWEETERS:** sealed back dynamic 8ohm tweeters: $5 ea. **CASED TRANSFORMERS:** 230V-11.7V-300mA AC-AC transformers in small plastic case with separate input and leads, each is over 2M long: $6. **WELLER SOLDERING IRON TIPS:** new tips Weller stations and mains operated Weller irons, mixed popular types, specify mains or station type: 5 for $10. **LCD CHARACTER DISPLAYS:** standard 16 x 1 displays, 5V operation: $20. **NICAD BATTERIES:** new Toshiba 7.2V-2.2AHr Nicad battery packs, 2 packs and one 12V intelligent charger (charger may be slightly soiled): $40. **STEPPER MOTORS:** 6V-6Wire-1.8deg. used stepper motors: $4 ea.

COMPONENTS

HIGH INTENSITY RED LEDs: 550-1000mCd @ 20mA, 100mA max, 5mm housing: 10 for $4, or 100 for $30. **BLUE LEDs:** 5mm: $2.50. **ELECTRET MICROPHONE INSERTS:** high output standard size omnidirectional: 10 for $8. Also some high quality unidirectional electrets that were removed from new equipment: $3 ea. **ULTRASONIC TRANSDUCERS:** high quality Murata 40KHz transmitter and receiver transducers: $4 pr., 40KHz Xtal to suit: $2. **3.57MHz XTALS:** 10 for $6. **OP27 OPERATIONAL AMPLIFIERS:** super operational amplifier ICs!: $3 ea. **ENCODER DECODER ICs:** as used in many projects, SC Dec 92, EA Mar 93 and 94, AX526/7/8 ICs: $3.50 ea. UHF Module to suit: $15. **DYNAMIC MICROPHONE INSERTS:** unidirectional low impedance inserts: $4 ea. **HIGH VOLTAGE DISC CERAMICS:** 680pF-3kV: 20 for $4, 0.015uF-3kV: $2 ea., 1000pF-15kV: $4 ea. **HIGH VOLTAGE DIODES:** all are very fast!, 1kV-1A: 10 for $5, 8kV-20mA: $1.50, 16kV-20mA: $2 ea. **GAS FILLED ARRESTORS:** 10 for $3. **THERMISTORS:** 2.5ohm NTC: 10 for $2. **TRIACS:** 600V-60A, CLEARANCE: $3 ea. **COMPRESSION TRIMMER:** 250pF, mica dielectric, new but may be slightly soiled, ceramic base: $1 ea.

MORE IR COMPONENTS

880nm/12 deg./30mW @ 100mA IR LEDs: 10 for $9.
880nm/60deg./30mW @ 100mA IR LEDs: 10 for $9.
940nm/12deg/16mW @ 100mA IR LEDs: 10 for $5.
IR detector pin diodes: 10 for $10.
5mW/780 nm laser diode (LTO26): $16 ea.

MORE ITEMS AND KITS

Poll our (02) 579 3955 or (02) 579 3983 fax numbers for instructions on how to obtain our Item and Kit lists. MANY MORE ITEMS AND KITS THAN ARE LISTED HERE!! You can also ask for a copy of these to be sent out with your next order.

PRODUCT SHOWCASE

Stereo headset has microphone

Jaycar Electronics has introduced a new telecommunications headset with a dynamic microphone attached. They have soft cushion leatherette earpads and headband and a weight of 250g, making them comfortable for sustained use. Their nominal impedance is 400Ω at 1kHz and rated input power is 30mW.

The dynamic microphone is 19mm in diameter, has an impedance of 200Ω and is supported by a 4.5mm goose neck tube. The headphone connection is via a 3.5mm stereo plug and a 3.5mm mono plug is used for the microphone. Both plugs come with 6.5mm adaptors.

The catalog number is AA-2022 and the price is $89.95 from all Jaycar Electronics stores and resellers.

VHF transistor has low feedback capacitance

Zetex has released a new NPN transistor for VHF applications. The BFS20, in an SOT23 package, has a feedback capacitance of 0.35pF which helps reduce Miller effect. It can handle pulsed currents up to 25mA, has a maximum Vcb of 30V, a maximum Vce of 20V and offers useful performance at 275MHz. The BFS20 is available on tape and reel in quantities of 3000 and 10,000 units.

Further information is available from GEC Electronics Division, Unit 1, 38 South St, Rydalmere, NSW 2116. Phone (02) 638 1888.

Industrial cases for PCs

The Knurr IPC Chasseleon Industrial PC case is now available, having been designed to accommodate the increasing range of industrial PC products. Low noise fans producing a level less than 30dB are used, along with

Scopemeter now has 100MHz bandwidth

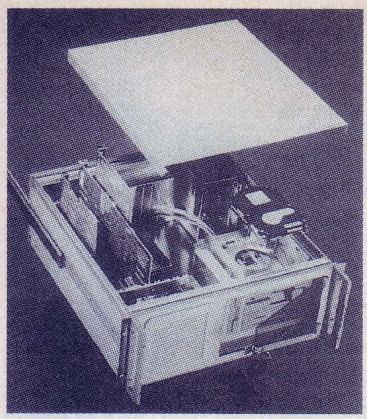
The new Fluke 105 Scopemeter series II has a bandwidth of 100MHz. It combines the high bandwidth of a digital storage oscilloscope and a true RMS digital multimeter into a compact battery powered instrument. Unlike some complex oscilloscopes, the Fluke 105 is easy to use, offering menu driven operation and one button access to over 30 common measurements.

The Scopemeter allows the user to switch quickly between meter and scope functions. In either mode, the unit provides both numeric readings and waveform display of the measured signal. The

desired measurement is simply selected and the unit automatically configures itself. For complex signal measurements, the Continuous Autoset function continually selects the appropriate timebase, input range, trigger level and trigger slope as the input signal is changed. At any time, these settings can be made manually.

The true RMS digital multimeter can measure up to four parameters simultaneously, while displaying the signal waveform. These include square waves, pulse trains and other non-sinusoidal voltages up to 5MHz.

For further information, contact Philips Scientific and Industrial, 34 Waterloo Rd, North Ryde, NSW 2113. Phone (02) 888 8222.



air baffles to ensure adequate PC board ventilation. The front-mounted fan air filter can be changed during operation.

All built-in components have a chromate finish to ensure adequate EMC shielding. A continuous rear panel with a recessed mounting protects connecting cables from mechanical damage.

The resulting enclosure can be mounted in a 19-inch rack or used as a freestanding bench unit. It is supplied fully wired and available with a comprehensive range of accessories.

For further information, contact Ricon Pty Ltd, 66-76 Dickson Ave, Artarmon, NSW 2064. Phone (02) 439 6078.

Marconi defects analyser

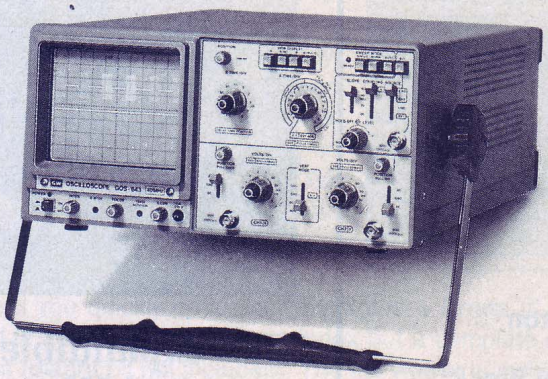
Marconi Instruments has announced the release of the Model TR-8 Manufacturing Defects Analyser (MDA). It is claimed that this new product offers analog test performance rivalling much more expensive units.

Several different measurement techniques and ranges can be selected to optimise each component test. For example, measurement amplitude can be chosen to prevent parallel diode interference or the selection of various stimulus frequencies can be optimised for the impedance of the components being measured. The TR-8's multi-amplifier guarding system can be used to isolate component measurements from other parallel circuitry.

Building on the proven features of Checksum's well established model TR-4 MDA system, the TR-8 can be extended to check for open connections to devices such as ICs or connectors with the optional HP TestJet technology.

For more details, contact Marconi Instruments Pty Ltd, Unit 1, 38 South St, Rydalmere, NSW 2116. Phone (02) 638 0800.

50MHz
Only $1,076*



GW Instruments is one of only 2 Taiwanese manufacturers of test and measuring instruments to be certified to the ISO9002 Quality Standard. This certification is your guarantee of a quality, yet most affordable 50MHz, 2CH scope available.

Features of the GW GOS-653 Oscilloscope include:

- *50MHz, 2 Channels*
- *Maximum Sensitivity of 1mV/DIV*
- *Auto Trigger Level Lock uses a special pk-pk detector*
- *Alternate Trigger Mode to trigger asynchronous signals*
- *Variable Hold-Off ensures easy viewing of complex signals*
- *DC Trigger coupling for viewing low frequency signals*
- *Signal delay line to display leading edge*
- *12kV acceleration Voltage for bright display*
- *Channel 1 signal output can be connected to other instruments*

** Price quoted includes probes and excludes sales tax*

EMONA INSTRUMENTS

Available from Emona Offices Australia Wide:

NSW (02) 519 3933 QLD (07) 397 7427
VIC (03) 889 0427 WA (09) 361 4200

Also available from dealers around Australia.

Review by BOB FLYNN

Audio Precision System One Analyser

In 1985, a new company, Audio Precision, Inc, introduced an automated test set for the measurement of audio equipment. Ten years later, the system has been considerably upgraded & is still regarded as the world's best. Here are our impressions of the system after several months' use.

Since the earliest days of audio, engineers have needed to know the performance of the equipment they have designed. As time has passed, the range of tests has become more extensive and detailed. For example, the basic parameters to describe the performance of a power amplifier may be as follows: Gain, Frequency Response, Power Output, Signal-to-Noise ratio, Total Harmonic Distortion and Intermodulation Distortion.

Parameters such as gain, bandwidth and power output are relatively easy measurements to make, requiring no more than a sinewave oscillator with a variable output and flat across the audio band, an RMS-reading voltmeter (with a bandwidth greater than that of the device being measured), a dummy load and an oscilloscope so you can spot the onset of distortion (ie, clipping).

Signal-to-Noise ratio requires the above gear and an AC millivoltmeter, although for really quiet equipment, you need a millivoltmeter which will read down to microvolts. For example, a noise measurement of -115dB below 20V equates to a reading of only 35µV. For these tests, you also need bandwidth limiting and weighting filters (eg, for A-weighted tests).

For harmonic and intermodulation distortion, the test equipment list grows longer. Originally, for harmonic distortion tests, you needed an audio generator to provide the test signal and a harmonic analyser. Setting the

generator's frequency was never a bother but trying to match the notch filter in the analyser to that frequency was another story.

In our lab, we have an old Radford "Distortion Measuring Set" and this is quite a beast to drive. As well as a large handspan dial labelled "Rejection Frequency Tuning" and a "Rejection Frequency Range" switch, it has two knobs marked "Coarse Tuning", two marked "Medium Tuning" and two more marked "Fine Tuning"; seven tweaks to drive you up the wall! Besides the inevitable drift in the generator frequency, you were also fighting the analyser's own drift. Finding a true null with this device was almost a miracle.

Later test sets combined the audio generator in the same case as the distortion analyser. The tuning of the notch filter was then coupled to the setting of the test signal frequency. Servo circuitry kept the notch filter in track with the generator, to relieve the operator of the fiddly task of nulling. Further circuitry automatically adjusted the voltmeter so that the analyser input level was automatically set at 100%. So it could be said that these instruments were partly automated.

This was a big improvement over previous instruments but making a "THD versus frequency" test, for example, still meant the operator setting each plot frequency on the generator, waiting till the analyser settled, then plotting each reading on graph paper. Producing a series of such plots under different operating conditions could take many hours or even days.

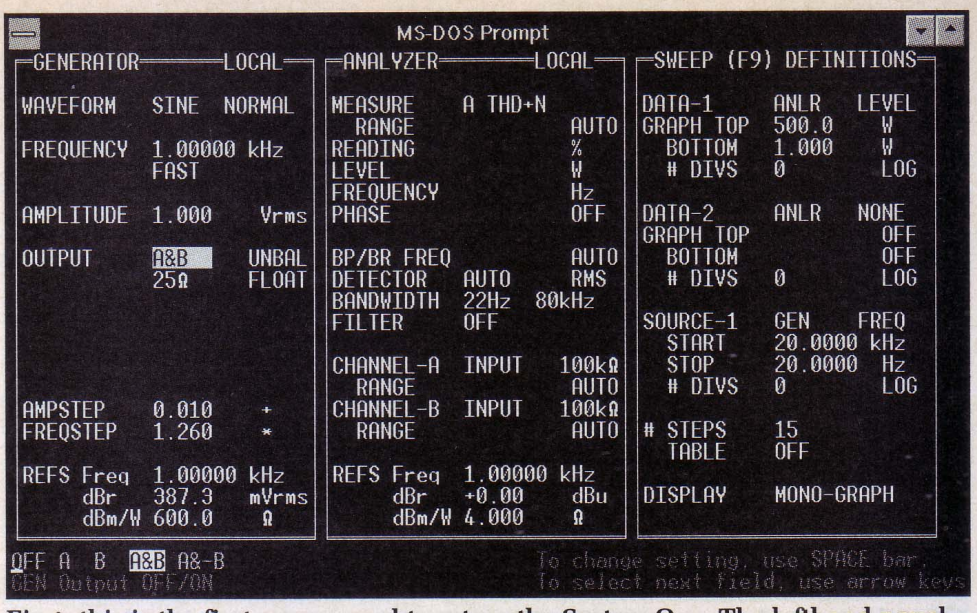


Fig.1: this is the first screen used to set up the System One. The lefthand panel is for the Generator while the middle panel sets up the Analyser.

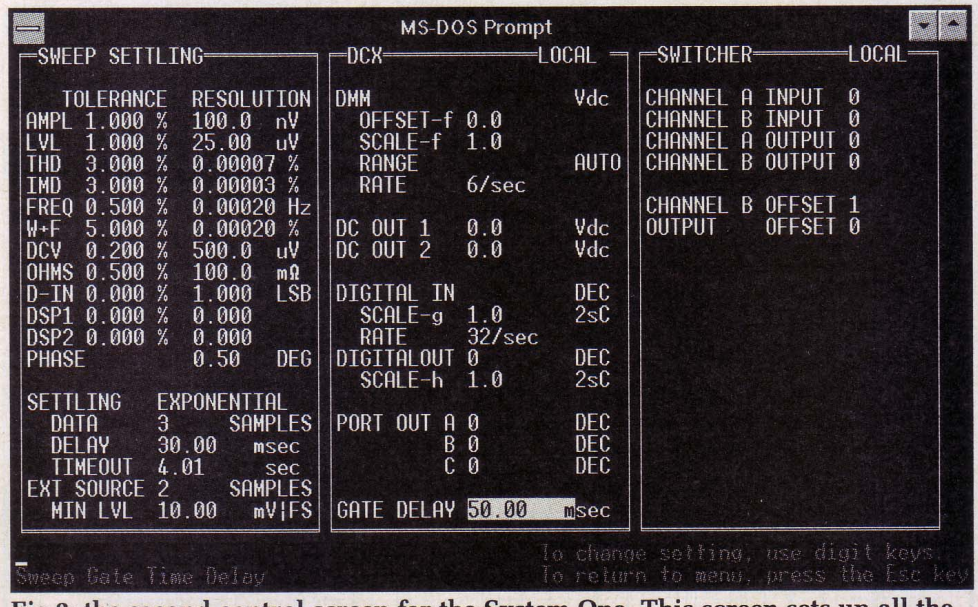


Fig.2: the second control screen for the System One. This screen sets up all the settling parameters.

Automated testing

All this changed in 1985, when Audio Precision produced their System One audio test set which was controlled by an IBM PC. The test set reviewed here is the System One, Model SYS-22. The SYS-22 is a stereo analog audio test set comprising a 2-channel generator and 2-channel analyser. Available options for the System One include weighting filters, tone burst generation, intermodulation distortion measurement, wow and flutter measurement, and a digital signal processor (DSP). External options include the DXC-127 DC (a DC voltage source, a DC voltage and resistance meter and a digital input-output device) and SWR-122 switcher modules (these allow multi-point and multi-channel testing of equipment).

Our unit has the options for intermodulation distortion, tone burst tests and the A-weighting filter. Perhaps the most important other option is DSP (Digital Signal Processor) and this enables analysis of digital audio equipment such as CD players, Mini-Disc and DAT recorders and also has Fast Fourier Transform (FFT) analysis to allow full audio spectrum analysis.

System One is large, heavy and initially at least, quite inscrutable. It has no switches or knobs, no dials or displays or, in fact, anything that the user can directly control. It is totally controlled via an interface card which is installed in an accompanying IBM PC computer.

The System One measures 438mm wide, 133mm high and 432mm deep and it weighs about 15kg. The upper left half of the front panel accommodates the generator output sockets, comprising two three-pin male XLR sockets and six banana jacks. Below these sockets are three BNC connectors, for a sync output, a trigger input and a monitor output (eg, oscilloscope). The righthand side of the panel is devoted to the analyser inputs, with two three-pin female XLR sockets, five banana sockets and a BNC connector.

Below these are five BNC sockets arranged in a two groups. Three of these are monitor outputs, while the other two are for external filters.

Outputs of the generator may be balanced or unbalanced, floating or

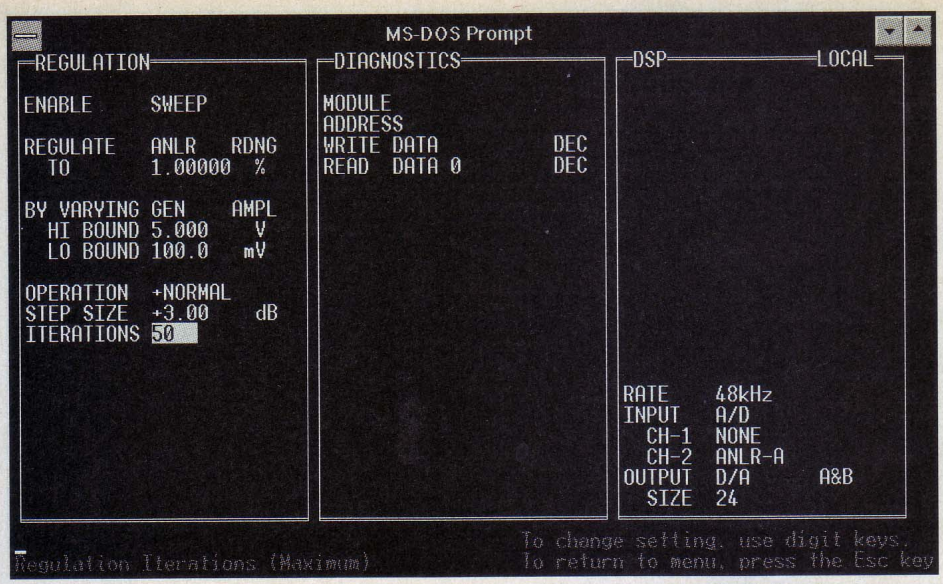


Fig.3: this control screen is set up to measure the power bandwidth of an amplifier at 1% rated harmonic distortion.

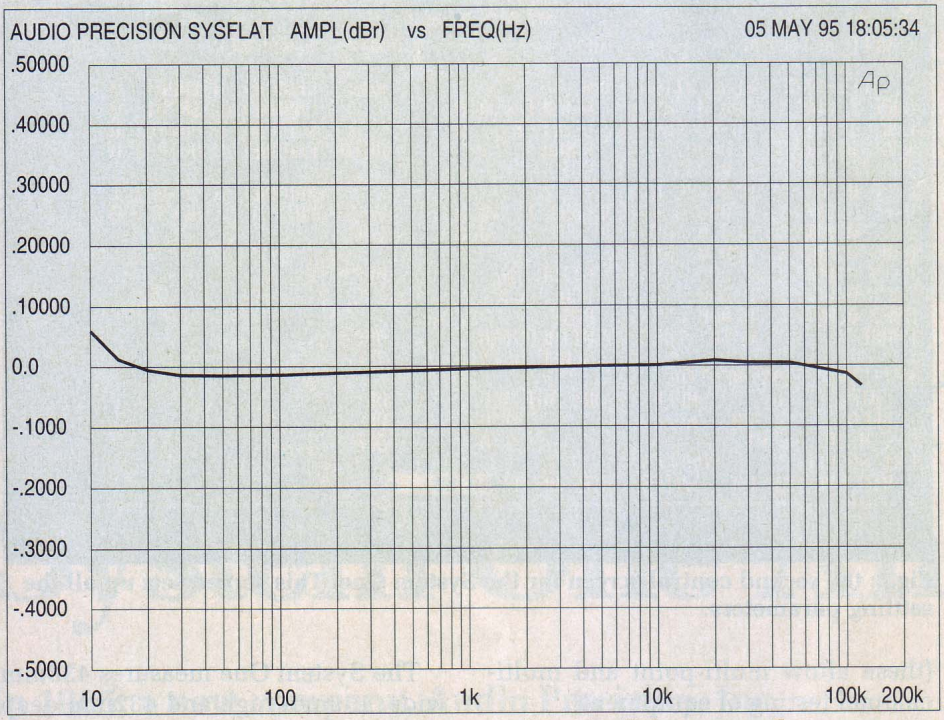


Fig.4: a self-test of the System One showing the overall frequency flatness, using a measurement bandwidth of 500kHz. The specification is 20Hz to 20kHz ±0.05dB.

grounded. In floating mode, source impedance can be 50Ω, 150Ω or 600Ω. In unbalanced mode, it can be 25Ω or 600Ω. The analyser inputs are balanced and the impedance can be set at 150Ω, 600Ω or 100kΩ. The low impedance terminations are automatically removed if the input exceeds 30V.

Along with the test set and previously mentioned interface card, the System One comes with a set of program discs and a comprehensive user's manual. System One may be run on any IBM or IBM compatible machine through to 80486 machines. The computer needs at least 640Kb of memory, DOS 2.2 or later versions and a Hercules, CGA, EGA or VGA monitor. We installed the software and the interface card in a 386SX computer and experienced no problems. Connection between the computer and the System One is made via a supplied cable fitted with 25-pin D connectors.

The software runs under DOS (ie, non-Windows) and as supplied with our version, the program contains about 80 test files and 13 procedure files. Test files are compiled to carry out a specific test; eg, THD+N versus Frequency, THD+N versus Amplitude, Crosstalk etc. The user can generate custom test files or make modifications to the supplied tests. A procedure is a file that will execute a series of tests and sub-procedures in a fixed order. Procedures are particularly useful for production tests and quality control. Once a procedure has been established by the production manager, non-technical staff can run tests on a product and every time the procedure is run the test parameters remain the same.

With everything ready to go we were keen to put the system through its paces. A good place to start is SYS-22CK.PRO, a procedure file with eight tests to check key parameters of the system. After this procedure is finished, a report of the response of the instrument to each test is shown. If any of the parameters is outside the specifications, then the instrument is in need of recalibration or servicing.

The command S1 starts the program and the Audio Precision logo appears with a command line below it. This command line shows a menu of fourteen single word commands; eg, Run, Panel, Load, Save etc. One letter commands are enough to produce action and entering (L)OAD, brings up the next command line with a further 10 commands such as Test, Limit, Procedure, etc. Entering (P)ROCEDURE displays a list of the Procedure files. Picking SYS22CK loads that procedure, then entering (R)UN followed by (P)ROCEDURE starts the series of eight tests.

The result of each test is displayed on the monitor in either graphical or tabular form. The total time to run the eight tests and the tolerance report was less than 90 seconds. As you would expect, the instrument comfortably exceeded the specifications for all tests.

Sample tests

The following is not intended to be a blow by blow description of how to use System One but rather to give a rough idea of what needs to be done to set up a test. If a test is loaded and (P)ANEL is entered then the screen shown in Fig.1 appears. The left hand panel titled GENERATOR shows the

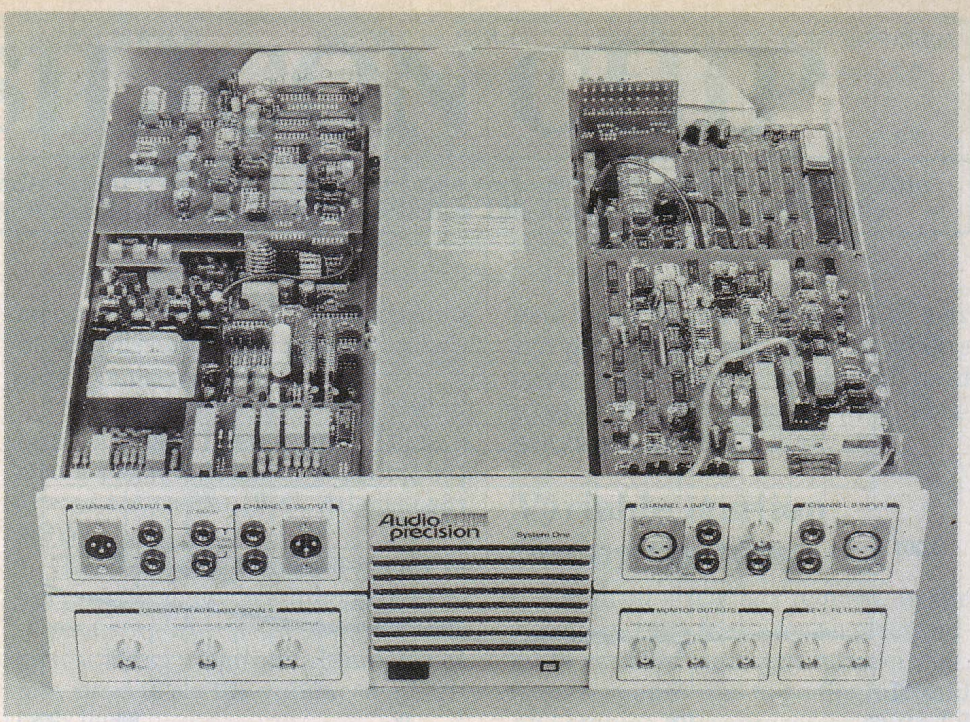
generator setup with the key functions such as WAVEFORM in the leftmost column. If the highlighting bar is moved, either by the keyboard cursor keys or the mouse, to cover a word to the right of any of the key functions, then the command line at the bottom of the screen shows the options available for that field. For example, if NORMAL, to the right of WAVEFORM, is highlighted then the COMMAND options available are NORMAL, BURST, TRIG, GATE.

Highlighting the figure next to FREQUENCY allows you to key in the generator frequency, or by pressing the + key, increasing the frequency by the factor shown next to FREQSTEP if "*" is selected to the right of FREQSTEP. Similarly, highlighting the figure to the right of AMPLITUDE allows you to key in some other signal voltage or by pressing the plus key, increasing the amplitude by the voltage shown next to AMPSTEP if + is selected to the right of AMPSTEP. Highlighting the field to the right of OUTPUT gives you the option of selecting OFF, (channel) A, B, A&B, A&-B. In other words, you are setting up the generator with the keyboard instead of switches and potentiometers.

The centre screen panel is titled ANALYSER and here again by highlighting the words to the right of the key functions, the analyser can be set up. Immediately to the right of MEASURE is a field allowing you to choose channel A or channel B. Further to the right again is a field giving measurement options: AMPLITUDE, BANDPASS, BANDREJECT, THD+N, SMPTE, CCIF, DIM W+F, 2-CHAN and CROSSTALK. Similarly, to the right of the function READING are the options %, dB, PPM, X/Y and OFF. READING is just what it says; the parameter being measured. LEVEL can be set to V, dBm, dBu, dBv, dBr, W, OFF. This is the signal level into the analyser before any filtering or tailoring.

To the right of BANDWIDTH the first field allows you to choose the low frequency cutoff and the next field the high frequency cutoff.

The righthand panel titled SWEEP (F9) DEFINITIONS allows the user to set up the tests with sweeps of frequency or amplitude measurements versus time. To the right of DATA-1 near the top of the panel can be selected the parameters to be plotted, ANLR (analyser), GEN (generator), DCX (not fitted) or DSP (not fitted).



The Audio Precision test set can be fitted with a large range of options, including DSP analysis for equipment such as DAT & MiniDisc recorders.

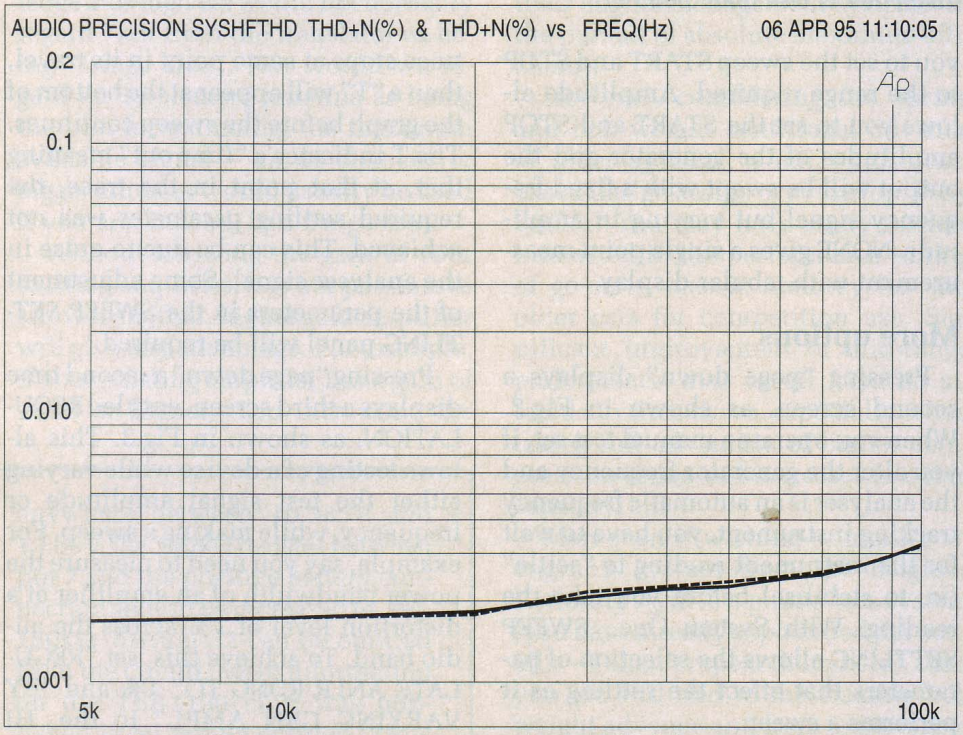


Fig.5: a self-test of the System One showing the residual harmonic distortion & noise between 5kHz and 100kHz, with a measurement bandwidth of 500kHz.

Further to the right can be selected RDNG, LEVEL, FREQ, PHASE, NONE. DATA-2 can be changed to SOURCE-2, HOR-AXIZ, or STEREO. SOURCE-2 allows two types of parameters to be swept in the one test. Hor-axis permits two measured values to be plotted against one another. Stereo generates consecutive sweeps, the first through one channel after which the generator output and analyser inputs are switched by System One and the same sweep is performed on the second channel.

SOURCE-1 is the swept independent variable and can be set to GEN, ANLR, SW1, DCX, DSP, EXTERN. With GEN selected, for example, the next field to the right gives the following options: FREQ, AMPL, TB-ON, TB-INT, TB-LVL or NONE. Frequency allows

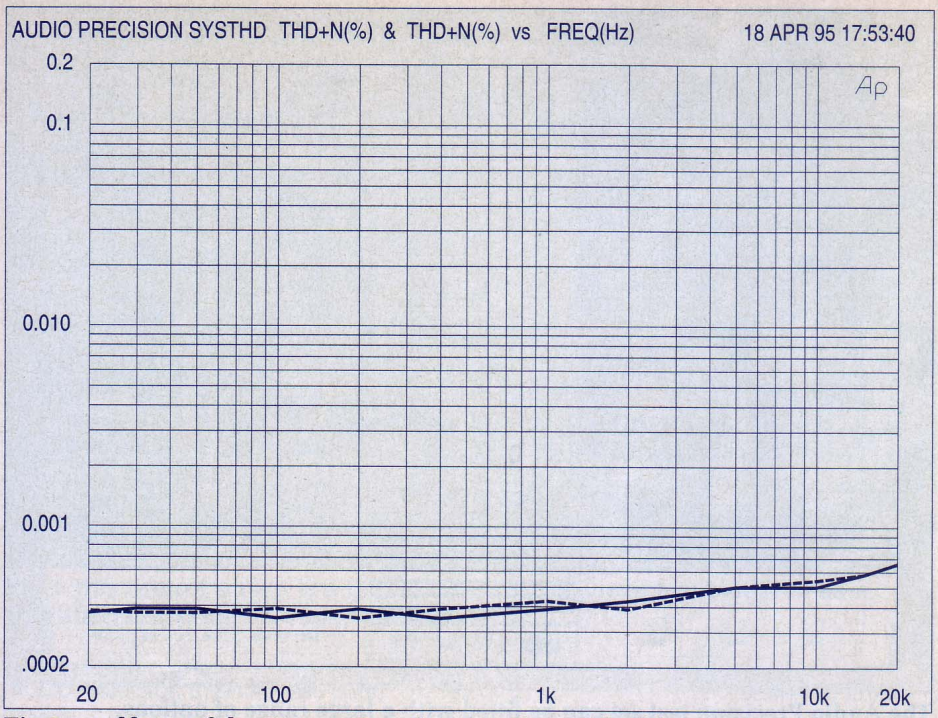


Fig.6: a self-test of the System One showing the residual harmonic distortion and noise of both channels between 20Hz and 20kHz. Note that below 5kHz, the distortion is less than .0005%!

you to set the sweep START and STOP to the range required. Amplitude allows you to set the START and STOP amplitudes of the generator and the output will be swept with a fixed frequency signal but varying in amplitude. NONE gives a single point measurement with tabular display.

More options

Pressing "page down" displays a second screen, as shown in Fig.2. When you operate a manual test set, if you alter the generator frequency and the analyser is an automatic frequency tracking instrument, you have to wait for the instrument reading to "settle" (ie, to stabilise) before you take the reading. With System One, SWEEP SETTLING allows the selection of parameters that effect the settling as it performs a sweep.

If, while a sweep is being run, the trace stops at some point in its travel, then a "T" will appear at the bottom of the graph before the sweep continues. The T indicates a "time out" meaning that, at that point in the trace, the required settling parameter was not achieved. This can be due to noise in the analyser signal. Some adjustment of the parameters in the SWEEP SETTLING panel will be required.

Pressing "page down" a second time displays a third screen, entitled REGULATION, as shown in Fig.3. This allows testing of a device while varying either the test signal amplitude or frequency, while making a sweep. For example, say you need to measure the power bandwidth of an amplifier at a distortion level of 1% across the audio band. To achieve this, set "REGULATE ANLR RDNG TO" 1% and "BY VARYING GEN AMPL" to the HI BOUND and LO BOUND levels you think are adequate and ENABLE (the top line) to SWEEP. When the power output versus frequency sweep is now made the generator amplitude will be varied to maintain the measured distortion level at 1%.

Printouts

Having made a test and deciding that the displayed graph is the one to keep, what methods are available to keep a record? If you have a dot matrix or HP LaserJet printer connected to your computer, then a screen dump can be made by typing a <*> (asterisk). However, the printout will only be as good as your monitor's resolution. If though, you start the program with <s1/g> and then after running your test you press the escape key, the command line appears at the bottom of the screen. Typing (S)AVE brings up another menu. Pressing (G)RAPHICS then allows you to save the graph as a .GDL (Graphics Display List) file. There are also two utilities in the program: Post and Plot. Post allows you to convert the .GDL file to a Postscript or EPS file and Plot will let you convert it to an HPGL plotter file.

Well, having had the use of System One for some months now, what are my impressions? At first, while very pleased with the instrument's performance, I could not help feeling that I had been removed a couple of steps from the testing procedure. Maybe it was the fact that I was now setting up the generator and the analyser on a keyboard, with no more twiddling of switches and pots and no more waiting for the instruments to settle. I cannot say I missed plotting the results on graph paper with a pencil though. This feeling of being remote from the testing soon passed.

The more you use System One, the more things you find it can do. Now I would hate to have to return to the old manual way of doing the job. This is truly automated audio testing. The only thing that the operator needs to be aware of is interference from the monitor's radiated timebase. While the System One is very well shielded, there is a need to take care to keep it out of the device being tested.

The System One and other distortion test sets by Audio Precision, Inc are distributed in Australia by I.R.T. Electronics Pty Ltd, 26 Hotham Parade, Artarmon, NSW 2064. Phone (02) 439 3744. **SC**

Key Specifications

Total System THD+N	<.0015% from 20Hz to 20kHz, with 80kHz measurement bandwidth; <.001% from 20Hz to 20kHz, with 22kHz measurement bandwidth
Total System Flatness	±0.05dB, 20Hz to 20kHz
Total System IMD	<.0018% SMPTE; <.002% DIM; & <.0005% CCIF
Analyser Residual Noise	<1.5µV (-114dBu) with 22kHz measurement bandwidth.

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Fringe area TV reception

I intend to build the Stereo FM Transmitter described in October 1988 but my stereo amplifier does not have a line out facility. Is it possible to run the transmitter from the headphone socket of the amplifier and, if so, are any modifications necessary?

I receive TV transmissions from translators all on the UHF band. The translators all operate on the same low power (I believe 50 watts). Being on the fringe area (about 7kms), it was necessary to have a masthead amplifier installed. It is not possible to receive signals from any other source including the main transmission towers due to a hill opposite unless I have a very tall antenna, about 12 metres high.

The antenna installed is about 750mm long with 11 small elements and a small reflector (4 elements) and is fixed to the highest point of the gable by a small J bracket. The reception is 95% on the main set (purchased 1995) and 90% on the second set (18 months old). There is a small amount of "snow" in the background of the picture which is more noticeable in a dark scene.

I have been led to believe this is the best reception I can expect. There is also a slight amount of ghosting, not always noticeable. (B. C., Adamstown, NSW).

• The FM stereo transmitter may be operated from the headphone outputs of your amplifier without any modification being required although you may need to set the volume at a fairly high level.

As far as your TV reception is concerned, we do not have local knowledge although we would not normally regard 7km from the translator as being "fringe area". Nor would we regard an 11-element antenna as being the best for extracting the maximum available signal – an 18-element or bigger antenna would usually be used if you are, indeed, in a fringe area.

Without knowing the gain of your existing amplifier, it is not possible to know if another, higher gain amplifier will give any advantage. For example, if your existing amplifier has a gain of 18dB or higher, then increasing the gain by adding another amplifier may not provide any reduction in picture snow. If that is the case, you will need a better antenna installation; ie, a bigger antenna or taller mast, etc.

Charger for cellular phone batteries

I'm interested in the Fast Charger For Nicad Cells, as described in the May 1994 issue of SILICON CHIP. Is there any chance of a circuit for charging mobile phone batteries? What happens if one connects a mobile battery to the above charger? Our two batteries are rated as 6V 650mA and 6V 1100mA so I presume that they have 5 cells internally. Most mobile batteries I have seen also have three connections. Can you explain? (G. W., London, U.K.)

• The May 1994 circuit should be suitable for charging 6V batteries with only a single resistor modification. Since pin 7 needs to sit anywhere between +0.385V and +3.85V, the 100kΩ resistor between pin 7 and the positive battery connection should be increased to, say, 150kΩ. Switch S2 can be omitted from the circuit. More information on the TEA1100 chip was published in an article entitled "How To Use The TEA1100 Fast Nicad Charger IC" in the September 1994 issue of SILICON CHIP.

We are not sure why mobile phone batteries have three terminals. It appears that two of the terminals are connected to the negative battery terminal while the centre terminal has quite a high resistance, 150kΩ in the case of batteries we had access to. We think this is used for voltage sensing in some charger modules.

Variable ignition timing circuits

I noticed a reader's request, in the February 1995 issue, for an electronically variable ignition timing circuit. Your response was to go the full quid and employ microprocessor control. I agree that this design route is the way to go in modern auto applications with their engine management systems, in the pursuit of absolute maximum efficiency.

However, considering the spring and bob weight centrifugal advance of older systems, a microprocessor-based design seems over the top. Why bother? You may have many readers interested in the performance tuning of go-carts, classic motorcycles and older cars for competition use. Significant improvement of mid-range performance *may* result from an altered advance curve, especially when taking full advantage of higher compression ratios and increases in cubic capacity, etc.

Moreover, if wishing to modify an engine's system from the original Kettering style to a points-less system (you have already expounded the benefits – I shan't repeat them here), then you are still tied to the existing bob weight advance and from experience, I have found this can sometimes severely complicate the "mechanical" adaptation of an electronic pulse system (to the exclusion of being able to adapt it at all!).

All that really is required is for the spark to be advanced from initial advance at idle to full advance somewhere approaching maximum revs, perhaps in three or four steps. In practice, the system might involve the spark to be mechanically fixed at full advance then to electronically retard the spark by some lag circuit, the

Radiator coolant alarm modifications

Your Coolant Level Alarm described in the June 1994 issue is the answer to a concern I have long held about temperature gauges /warning lights. Presently, I have built and installed one unit and have two under construction for the family fleet.

Being something of a "belt and braces" proponent, the unit I've already constructed is in a car having an oil pressure gauge, oil warning light and alarm buzzer (after an experience with a sheared oil pump drive – instant and complete oil pressure loss). But rather than add more lights and buzzers in the dash, I have used the lamp outputs of the coolant alarm to trigger a relay switching to earth in parallel with the existing oil pressure switch. Oil pressure failure will buzz and light continuously; coolant loss pulses these warnings.

However, it seems to me that the built in delay, nearly 15 seconds before the coolant alarm triggers, is longer than necessary, even given the need to allow for cornering, etc, surge (if any occurs in a sealed and pressurised cooling system). How do I shorten the delay, please?

One last "ask". I have a use for a "touch on, touch again off" touch pad switch in one of the current (-ve earth) cars. With help from the Dick Smith technical people, I've modified the Funway kit touch switch. It works fine on the bench but, despite their/my best endeavours, with the engine running, "noise" in the electrical system triggers it erratically. Have you published a touch switch circuit suitable for an automotive environment? (J. P., Kaleen, ACT)

• The 15-second delay in the Coolant Alarm is set by the 100µF capacitor at point A in the circuit. To reduce the delay, just reduce the capacitor value. However we think it should not be reduced below 22µF for the circuit to remain reliable and not give false alarms.

We have not published a touch switch for automotive applications. As with the Coolant Alarm, any circuit for automotive applications needs plenty of supply filtering and switch delays in order to be reliable.

amount of which is somehow determined by the pulse frequency.

Indeed, I understand there are commercial systems for a small range of classic motorcycles which do just that. Why not develop a circuit to match your excellent high energy system based on the Motorola MC334P chip?

The advance (retard) curve (or steps) would need to be able to be "fettled" for trial and error, then it is a relatively solvable task to arrange either a crank or camshaft operated pulse. I'm sincerely looking forward to an enlightening reply. (B. M., Klemzig, SA).

• The reason that we mentioned microprocessor control is that it is actually the simplest way of achieving the task. The problem is that ignition timing, measured in degrees of advance in the mechanical sense, amounts to a time delay which is inversely proportional to engine speed and also to the manifold vacuum. What happens is that as engine speed rises, vacuum advance is reduced and the centrifugal advance is increased.

In the electronic sense, just to maintain constant ignition timing at any engine speed requires that the time delay is halved for each doubling of engine speed. That is complicated enough but to reduce the delay even further, to give an increase in ignition advance (how much?) proportional to engine speed, requires a circuit timing characteristic which is inverse logarithmic – not easily achieved. This also implies that you are going to ignore manifold vacuum and just rely only on the electronic equivalent of centrifugal advance.

The engine revs must be continuously monitored with some sort of frequency measuring circuit and the time delay then varied, perhaps with a frequency-to-voltage converter circuit. This could be done but it seems to us that the results would be very much hit and miss if you did not know or were unable to compensate for the particular engine's characteristics. After all, if you have a particular engine in mind, do you know what the details of its timing curve are?

We note your comments about go-carts and classic motorcycles but would not most of these be 2-stroke engines with magneto ignition, and therefore even more difficult than conventional Kettering ignition systems to modify?

However, having made these points, we will have another look at the concept to see what might be achieved with conventional circuitry.

Long distance UHF TV reception

I'm studying Microelectronics at Griffith University and regularly enjoy your magazine for the projects and articles. I'd like to ask for your help and advice on a concern that no "professional" in the field seems to know. It's about distant television reception.

We live in Brisbane, approximately 10km from the metropolitan TV towers. Because we are right up next to the towers, we are in a shadow zone which gives us woeful reception, even though the towers are in very close proximity.

However, about 80km away there are UHF repeater transmitters. We have had a field strength test done on our site for these repeaters with the following results: UHF CH46-60 approximately 29dB (BTQ7, QTQ9, TNQ10, GC TEN); UHF CH61, 64 & 67 approximately 40dB (NBN, SBS, Prime). This was using a 91-element aerial. There was no observed ghosting or interference of any kind, just snow over a very sharp, clean picture.

The technician who did this said he can't really do anything about improving this. However, he did say that he could improve our metropolitan reception for about $600, an idea I immediately dismissed. Do you think we can somehow amplify this signal into something usable, say around 60-80dB? I can get hold of 40dB amps with very low noise levels for under $100 but I'd like to know if this will work and get rid of all the snow before I go ahead.

Is there any other way of achieving a better signal on these distant stations, such as connecting two antennas together? Please give me details as to how I can get a viewable picture out of what I already have and tell me where I can get really high gain antennas or boosters. Are phased array aeri-

als any good in my situation? (P. T., Toowong, Qld).

• While good UHF TV reception over such distances is feasible, you would probably need at least two high gain antennas phased together and with a masthead antenna. You could end up spending more than $600 and it would still probably be blotted out during wet weather.

Frankly, if you are within 10km of the Brisbane towers, you should be able to get first class reception on quite a simple antenna. We cannot understand how you could be in shadow at a distance of 10km unless there is a hill or a very large building between you and the transmitters. Even at 1km or less with a UHF transmitter, it is still possible to get a good signal by aiming the antenna up at the tower.

We suggest you have a look at your neighbours' TV reception for comparison and get a second opinion from another local antenna installer.

Different pots for equaliser

I have eight 20kΩ slider pots I retrieved from an old junked equaliser board and wanted to use them in your equaliser published in August 1989. What modifications are there to be done in order to use the later, instead of the quoted 50kΩ pots?

And could you also give me the formula used to work out the equalising frequency of the gyrators? (M. C., Lalor, Vic).

• You could use 20kΩ sliders for the equaliser we published but you could not use a mixture of 20kΩ and 50kΩ. If you have 20 20kΩ sliders, you will need to change the 5.6kΩ resistor associated with IC2a to 2.2kΩ and the associated 270pF capacitor should be increased to 680pF.

The formula used for calculating the centre frequency of a gyrator is the same as for a series LC circuit; ie, $f = 1/2\pi\sqrt{(LC)}$ where L = R1.R2.C.

Uninterruptible power supply for a computer

We have had a lot of power failures lately and, although they are usually only half a second or so in duration, they play havoc with our computer in the office, as they usually occur at the most inopportune times. I would like to make a UPS for the system, using a Jaycar 200W inverter (Cat. MI-5038) powered by a lead-acid battery, which in turn is charged by a standard battery charger.

The monitor could still be powered directly from the mains supply, in case the converter can't handle the load, and be switched on separately by hand. Alternatively, the Altronics 240V Power Relay (K-6070) could be used instead.

My question concerns the rating in amp/hours for the battery to give approximately 30 minutes of backup power, and the rating of the battery charger in amps, to continuously run the computer (ie, the charger is only on when the computer is on). (T. N., Kununurra, WA).

• If we assume that the computer draws around 100 watts on average, then the battery charger required would need to be rated at around 10A continuous, as a minimum. During periods when the computer draws more power, such as when disc drives are activated, the battery could make up the difference. To give a battery backup time of 30 minutes, you would need a battery rated for at least 100 amp/hours.

However, after having been discharged by the computer for 30 minutes, the charger will take several hours to completely recharge the battery, during which time it would be unable to also provide the power for the computer. If you wanted to reduce the charging time and run the computer at the same time, the charger would need a rating of around 25A continuous – the more, the better.

Your suggestion for powering the monitor directly from the mains comes unstuck once the power goes off. The inverter needs to be able to power the monitor as well and we suspect that the Jaycar 200W inverter would be inadequate to drive both the computer and the monitor together if you need a backup time of 30 minutes. With this in mind, both the charger and the battery size need to be increased again, probably by a factor of 2.

You should consider whether a backup time of 30 minutes is really justified. Have you considered a UPS card for your computer? This provides battery backup for just long enough for the computer to shut down in an orderly manner. They are on sale from computer retailers such as Rod Irving Electronics.

Adding inputs to the 120W PA amplifier

I am writing regarding the 120W PA Amplifier described in SILICON CHIP from November 1988 to January 1989. I wish to have more microphone inputs. Is this possible using this circuit or will I have to change the complete mixer/preamp stage? Is the amplifier power board able to be used directly along with the 16-channel mixing deck described from February to May 1990? (R. T., Mundubbera, Qld).

• It would be relatively simple to add two extra microphone input channels by building another preamp board. On the second board you would only include the circuitry for IC1, IC2, IC4 and IC5 and the outputs would be connected to the summing junction of IC3 at pin 2 (on the first preamp board), via 2.2kΩ resistors. However, care with the layout and shielding would be required to obtain minimum hum.

The power amplifier could be used directly with the 16-channel mixer.

Foot pedal for digital effects unit

The Digital Effects Unit described in the February 1995 issue of SILICON CHIP was very interesting and more kits like this should be featured in your magazine. But as a guitarist, I wondered how the circuit would have to be changed to allow the control of all the effects by use of separate foot pedals. (D. E., Palmwoods, Qld).

• The Effects In/Out switch can be located externally provided shielded cable is used. Use a separate shielded cable for the S3b connection with pin 19 of IC3 as the shield termination. The Echo on/off should be run in twin shielded cable with an earth to the shield. Alternatively, these functions could be controlled by relays. The remaining switches (Up, Down, Vibrato and Display) can be run in twin-lead wire.

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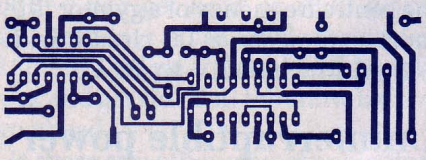

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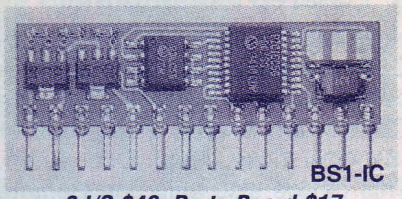

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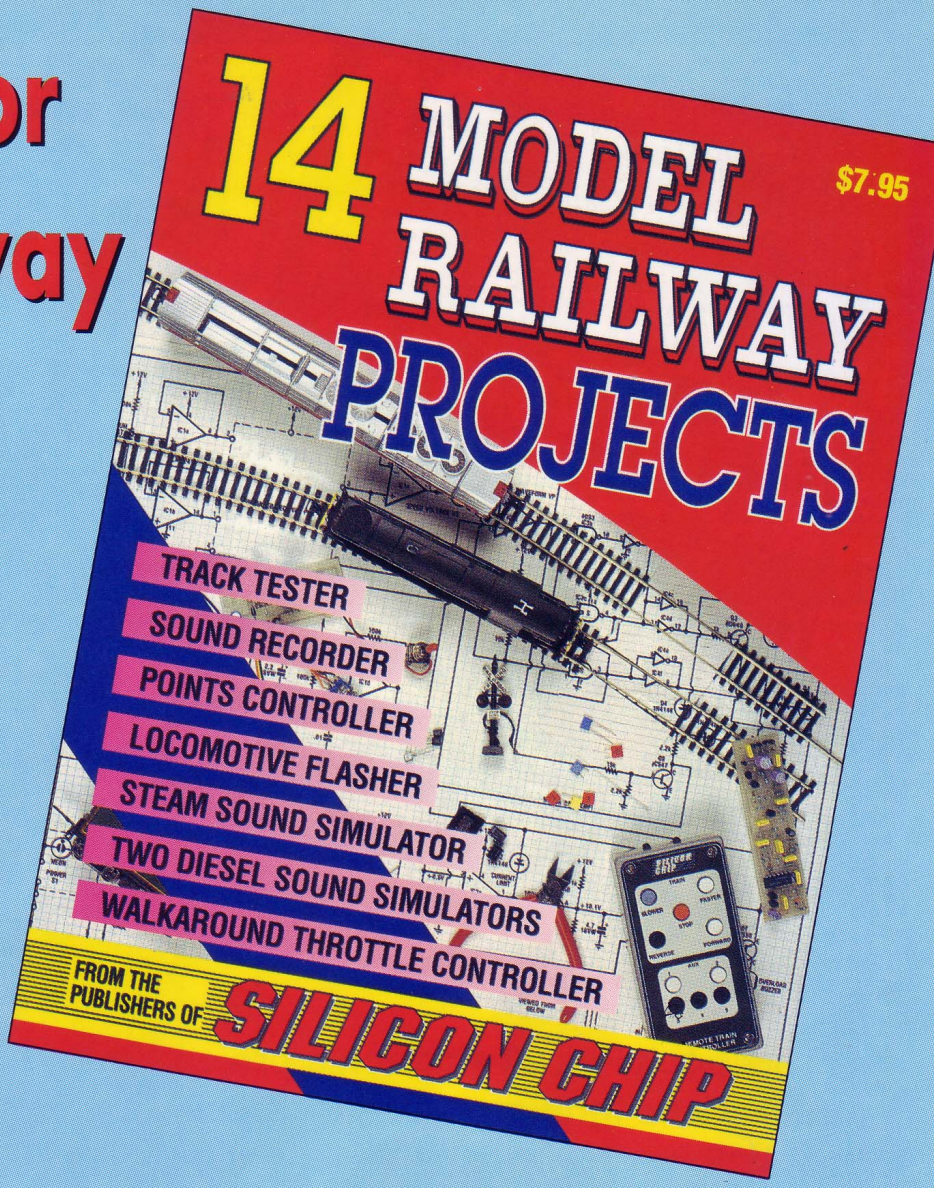

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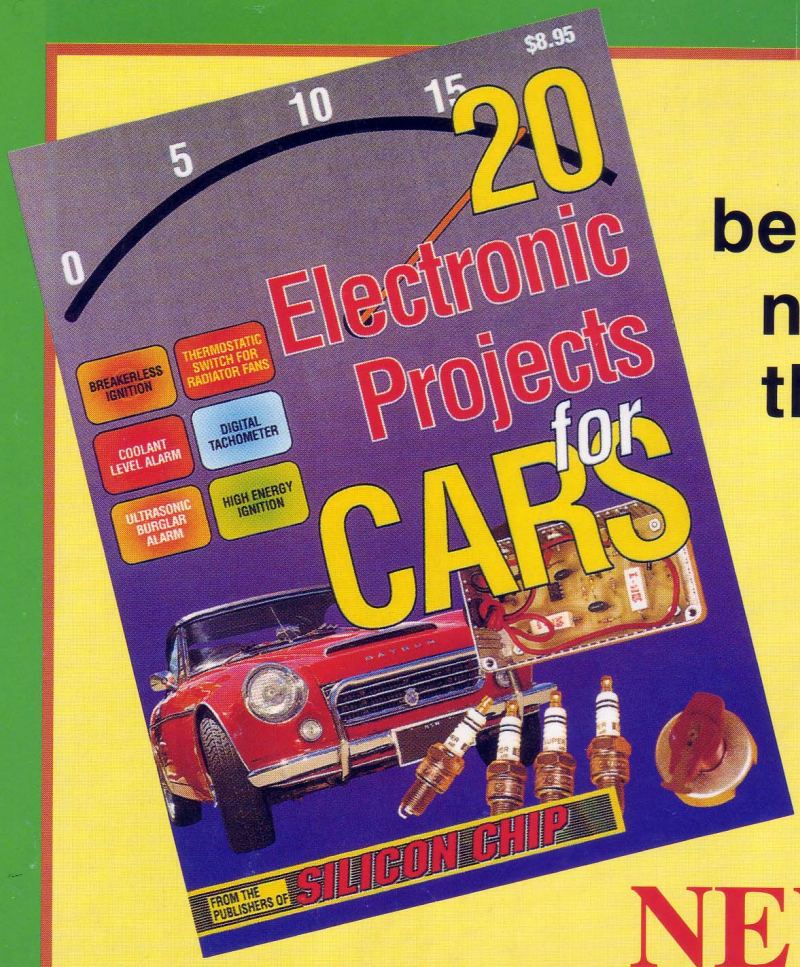

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